BRITISH MUSEUM (NATURAL HISTORY)

Dept. of mineralogy

CROMWELL ROAD, LONDON, S.W.

MINERAL DEPARTMENT.

AN INTRODUCTION TO THE STUDY OF METEORITES,

WITH A LIST OF THE METEORITES REPRESENTED IN THE COLLECTION ON JANUARY 1, 1904.

BY

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[This Guide-book can be obtained at the Museum; written applications should be addressed to "The Director, Natural History Museum, Cromwell Road, London, S.W."]

PRINTED BY ORDER OF THE TRUSTEES.

1904.

Gift
B.H.

LONDON:
PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,
DUKE STREET, STAMFORD STREET, S.E., AND GREAT WINDMILL STREET, W.

PREFACE.

In the accompanying list the topographical arrangement of those meteorites of the circumstances of the fall of which there is no satisfactory record has been adhered to. This mode of arrangement brings near together fragments which have been found in the same district at different times; in some cases they belong to the same meteoritic fall. As the dates of discovery or of recognition of meteoric origin, upon which other arrangements of meteorites are based, have been stated very differently in the published lists of the principal collections, a reference in each instance to the best available report, and a brief extract from it, are given.

Even as regards the dates of fall of the remaining meteorites there has been much discrepancy in the various lists: every case in which the date here given has been found to differ from that recorded in any other list has been verified by reference to reports of the fall.

L. Fletcher.

March 3, 1904.

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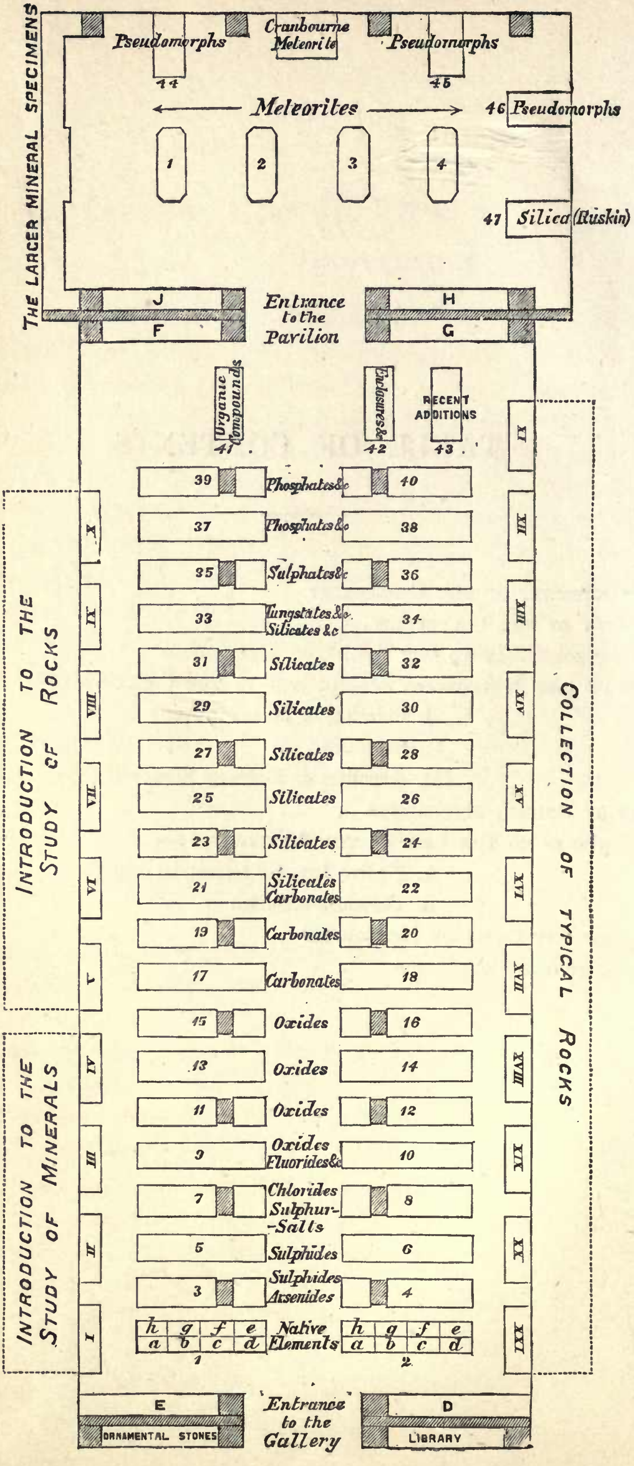
PLAN OF THE MINERAL GALLERY



ARRANGEMENT OF THE COLLECTION.

By ascending the large staircase opposite to the Grand Entrance and turning to the right, the visitor will reach a corridor leading to the Department of Minerals.

From the entrance of the Gallery the large mass of meteoric iron, weighing three and a half tons, found about 1854 at Cranbourne, near Melbourne, Australia, and presented to the Museum in 1862 by Mr. James Bruce, can be seen in the Pavilion at the opposite end of the Gallery.

The other meteorites will be found in the same room, the smaller specimens in the four central cases, and the larger on separate stands. The casts of meteorites are exhibited in the lower parts of the cases.

The specimens referred to in the 'Introduction to the Study of Meteorites' are in case 4, and are arranged, as far as is practicable, in the order of reference.

The remaining specimens are classified as :—

Siderites, consisting chiefly of metallic nickel-iron (panes 1*a*–2*d*):

Siderolites, consisting chiefly of metallic nickel-iron and stony matter, both in large proportions (panes 2*e*, 2*f*): and

Aerolites, consisting chiefly of stony matter (panes 2*g*–3*o*).

At the beginning of each class are placed those meteorites of which the fall has been observed.

The position of any meteorite in the cases may be found by reference to the Index (p. 100) and to the second column of the List of the Collection (p. 58).

HISTORY OF THE COLLECTION.

UNTIL nearly fifty years after the establishment of the British Museum, meteorite collections nowhere existed, for the reports of the fall of stones from the sky were then treated as absurd, and the exhibition of such stones in a public museum would have been a matter for ridicule; a few stones, which had escaped destruction, were scattered about Europe, and were in the possession of private individuals curious enough to preserve bodies concerning the fall of which upon our globe such reports had been given. Hence it happened that in 1807 not more than four meteoric stones were in the British Museum: three of them, *Krakhut*, *Wold Cottage* and *Siena*, had been presented in 1802–3 by Sir Joseph Banks; the fourth was a stone of the *L'Aigle* fall, presented in 1804 by Prof. Biot, the distinguished physicist. A fragment of the mass met with by the traveller Pallas had been presented by the Academy of Sciences of St. Petersburg as early as 1776; this, and the fragments of *Otumpa* and *Senegal River*, were long regarded by scientific men as specimens of "native iron," and of terrestrial origin.

In the year 1807, happily for the future development of the Mineral Collection, Mr. Charles Konig (formerly König) was appointed Assistant-keeper, and six years later was promoted to the Keepership of the then undivided Natural History Department; it thus came about that for thirty-eight years the senior officer of the Natural History Department of the Museum was one who had an intense enthusiasm for minerals and made them his own special study. It was in Mr. Konig's time that Parliament voted (1810) a special grant of nearly £14,000 for the purchase of the minerals which had belonged to the Rt. Hon. Charles Greville; with these passed into the possession of the Trustees fragments of seven meteorites, including *Tabor*, which had been ac-

quired by Mr. Greville with the mineral cabinet of Baron Born. The increase of the Natural History Collections was such that in 1827 the Botanical, and in 1837 the Zoological, specimens were assigned to special Departments, after which Mr. Konig, as Keeper of "Minerals (including Fossils)," was left free to devote his attention to those parts of Natural History to which he was more particularly attached.

During Mr. Konig's Keepership, though numerous and excellent mineral specimens were acquired, no great effort was made to render the meteorite collection itself complete; at his death in 1851, 70 falls were represented by specimens. The following had been presented:—

Stannern: by the Imperial Museum of Vienna, in 1814.

Red River: by Prof. A. Bruce, in 1814.

Mooresfort: by Mr. J. G. Children, F.R.S., in 1817, and by Dr. Blake, in 1819.

Limerick: by Dr. Blake, in 1819.

The large *Otumpa* iron, and a piece of the *Imilac* siderolite: by Sir Woodbine Parish, K.C.B., F.R.S., in 1826 and 1828 respectively.

Bitburg: by Mr. Henry Heuland, in 1831.

Krakhut: by Mr. Wm. Marsden, in 1834.

Cold Bokkeveld meteorite: by Sir John Herschel, Bart., F.R.S., Sir Thos. Maclear, F.R.S., and Mr. E. Charlesworth, in 1839 and 1845.

Zacatecas: by Mr. T. Parkinson, in 1840.

Akbarpur: by Captain P. T. Cautley, in 1843.

Braunau and *Seeläsgen:* by the Royal Society, in 1848.

After the death of Mr. Konig, Mr. G. R. Waterhouse, palæontologist, was appointed Keeper of the composite Department. It was natural that the palæontological side should then have its turn of special development, and in fact the palæontological collections, already important, increased from that time with great rapidity; the mineralogical side, however, had additions made to it, though not in the proportion allotted during the preceding years. During the Keepership of Mr. Waterhouse (1851–7), only specimens of two additional meteorites were added to the collection; one of them, *Madoc*, was presented in 1856 by Sir Wm. E. Logan,

F.R.S.; also additional fragments of *Imilac* were presented by Mr. W. Bollaert in 1857.

In the year 1857, a further division of the Natural History Collections took place; the mineralogical and the palæontological specimens being assigned to special Departments, and the Minerals placed in the Keepership of Prof. Story-Maskelyne. Under him the Mineral Collection was rendered as complete as possible in all its branches; and it is owing entirely to the unflagging energy he displayed, both in the search for, and in the acquisition of the best obtainable specimens, that the Mineral Collection was brought to its present position of general excellence. Perhaps the greatest relative advance was made in the improvement of the Collection of Meteorites. Perceiving that only half of the falls represented at Vienna were represented in the British Museum, and that the difficulty of making a fairly complete collection of such bodies must increase enormously as time went on, owing to the absorption of the specimens by public museums, Mr. Maskelyne immediately after his appointment tried to fill up the gaps. In the first place, the meteorite collections of Dr. A. Krantz, Mr. R. P. Greg, and Mr. R. Campbell, and many meteorites belonging to Mr. W. Nevill and Prof. C. U. Shepard, were acquired by purchase in 1861–2. During the interval (1857–63), the whole or parts of many meteorites were presented to the Museum :—

From Great Britain.—*Perth:* by Mr. W. Nevill.

From Russia.—*Tula:* by Dr. J. Auerbach of Moscow.

From India.—*Bustee, Dhurmsala, Durala* and *Shalka:* by the Secretary of State for India.

Assam, Butsura, Futtehpur, Khiragurh, Manegaum, Mhow, Moradabad, Segowlie and *Umballa:* by the Asiatic Society of Bengal.

Nellore and *Parnallee:* by Sir W. T. Denison, K.C.B.

Kusiali and *Pegu:* by Dr. Thos. Oldham, F.R.S.

Kaee: by Sir Thos. Maclear, F.R.S.

Dhurmsala: by Mr. G. Lennox Conyngham.

From Australia.—The large *Cranbourne* iron: by Mr. James Bruce.

From South America.—*Vaca Muerta:* by Mr. W. Taylour Thompson.
Imilac: by Mr. W. Bollaert.
An *Atacama* iron: by Mr. Lewis Joel.

From North America.—*Tucson:* by the Town Authorities of San Francisco.

During the same interval, exchanges were made with the museums of Paris, Vienna, Berlin, Copenhagen, Heidelberg, and Göttingen, through Professors Daubrée, Haidinger, Rose, Hoff, Bunsen, and Wöhler, respectively: and also with the following private collectors:—Dr. Abich of Dorpat, Dr. J. Auerbach of Moscow, Mr. R. P. Greg of Manchester, Prof. C. U. Shepard of New Haven, U.S.A., and Dr. Sismonda of Turin.

The result was that by the end of 1863 the number of meteoric falls represented in the collection was 207, and thus had been almost trebled during Mr. Maskelyne's first six years of office.

Meanwhile, although Mr. Maskelyne, with the help of a single assistant (Mr. Thomas Davies), was then rearranging the general collection of minerals according to a new system of classification, time was found for a scientific examination of the meteorites thus being acquired. At that time the Department was without a chemical laboratory, and not even a blow-pipe could be used, owing to the necessity of guarding against a possible destruction of the Museum by fire. Hence recourse was had to the microscope, and as early as 1861, a microscope fitted with a revolving graduated stage and an eye-piece goniometer was constructed, under the Keeper's directions, for the examination of thin sections of meteorites with the aid of polarised light.

Working in this way, and with the simplest chemical tests, Mr. Maskelyne was the first to announce in 1862 the discovery in the Bustee meteorite of a mineral, unknown in terrestrial mineralogy, to which he gave the name of Oldhamite, and in 1863, the more than probable occurrence

of Enstatite as an important meteoritic ingredient (Nellore). This method of determining the mineral constituents of a rock-section by means of the relation of the vibration-traces to known crystallographic lines, thus first and of necessity employed for the discrimination of the minerals in meteorites, is now in general use in the investigation, not only of meteoritic, but of terrestrial rocks. About the same time, from the Breitenbach meteorite were extracted crystals of Bronzite, which yielded the first crystallographic elements obtained for that mineral: the measurements were made and published by Dr. Viktor von Lang, then assistant in the Department (1862–4) and now Professor of Physics at Vienna.

The microscope was further applied to the mechanical separation of the different mineral ingredients of a meteorite: and by picking out in this toilsome manner the different mineral ingredients from the crumbled material of the Bustee aerolite, and from the residue of the Breitenbach siderolite left after the iron had been removed by mercuric chloride, the several silicates contained in these meteorites were isolated for future analysis. From the particles of colourless mineral thus obtained from the Breitenbach meteorite, one kind was selected in 1867, of which the crystals presented a zone of orthosymmetry containing two optic axes, and yielded two similar cleavages in a zone perpendicular to the former. This ingredient was afterwards (1869) announced to consist wholly of silica, a substance which, before the isolation of this mineral, was only known to occur as quartz, when in crystals, and these belong to the hexagonal system: to the new mineral Mr. Maskelyne later assigned the name of Asmanite. In 1868 was published by Vom Rath the discovery of a species of terrestrial silica, the crystals of which were regarded as belonging to the hexagonal system, though their angular elements were distinct from those of quartz: this mineral, named by him Tridymite, has since been found (1878) to present optical and other characters inconsistent with true hexagonal symmetry, and is probably identical in its specific characters with the meteoritic asmanite.

Further, another mineral occurring as minute gold-yellow

octahedra in the Bustee meteorite was recognised as new to mineralogy, and termed Osbornite.

It was not till 1867, when a laboratory was fitted up outside the Museum precincts, that it became possible to make a complete chemical examination of these materials, which had been gradually prepared and carefully picked for analysis. In that year the late Dr. Walter Flight was appointed to assist in the laboratory-work of the Department, and afterwards gave valuable help in the chemical analysis of the above materials: the results were quite confirmatory of those already obtained by aid of the microscope and the simple tests.

Since the great increase made during the first six years of Prof. Maskelyne's Keepership, the Collection has continued to grow, though necessarily at a less rapid rate.

Of the specimens added after 1863, the following have been presented:—

1864–7: *Manbhoom, Muddoor* and *Pokhra:* by Dr. Thos. Oldham, F.R.S.

1864: *Agra:* by Mr. Wm. Nevill.

1864: *Atacama* (stone): by Mr. Alfred Lutschaunig.

1865–70: *Jamkheir, Lodran, Shytal, Supuhee* and *Udipi:* by the Secretary of State for India.

1865: *Nerft:* by Prof. Grewingk.

1865: *Ski:* by Prof. Kjerulf.

1867–70: *Goalpara, Gopalpur, Khetri, Moti-ka-nagla, Pulsora* and *Sherghotty:* by the Trustees of the Indian Museum, Calcutta.

1867–75: *Knyahinya* and *Zsadány:* by the Hungarian Academy of Sciences.

1869: *Krähenberg:* by Dr. Neumayer.

1871: *Searsmont:* by Dr. A. C. Hamlin.

1873: Fragments of thirteen meteorites already represented: by Mr. Benj. Bright.

1874: *Bethany:* by the Trustees of the South African Museum, Capetown.

1875: *West Liberty:* by Dr. G. Hinrichs.

1876: *Shingle Springs:* by Mr. E. N. Winslow.

1876: *Rowton:* by the Duke of Cleveland.

1877: *Khairpur* and *Jhung:* by Mr. A. Brandreth.
1877: *Verkhne-Dnieprovsk:* by Prof. Koulibini.
1878: *Cronstad:* by Mr. John Sanderson.
1878: *Santa Catharina:* by Prof. Daubrée.
1879: *Imilac, Mount Hicks* and *Serrania de Varas:* by Mr. George Hicks.
1881: *Middlesbrough:* by the Directors of the North Eastern Railway.
1882: *Veramin:* by the Shah of Persia.
1882: *Vaca Muerta:* by Mr. F. A. Eck.
1883: *Ogi:* by Mr. Naotaro Nabeshima, formerly Daimiô of Ogi, Japan.
1885: *Ivanpah:* by Mr. H. G. Hanks.
1885: *Youndegin:* by the Rev. Charles G. Nicolay.
1885 *et seq.*: *Ambapur Nagla, Bishunpur, Bori, Chandpur, Donga Kohrod, Esnandes, Gambat, Heidelberg, Kahangarai, Kodaikanal, Lalitpur, Nagaria, Nammianthal, Nawalpali, Pirthalla, Sindhri, Wessely* and *Wöhler's iron:* by the Director of the Geological Survey of India.
1885: *Lucky-Hill:* by the Governors of the Jamaica Institute.
1886: *Nenntmannsdorf:* by Dr. H. B. Geinitz.
1886: *Jenny's Creek:* by Mr. John N. Tilden.
1887: *Djati-Pengilon:* by the Government of the Netherlands.
1887: *Glorieta Mountain:* by Mr. Richard Pearce.
1889: *Bhagur* and *Kalambi:* by the Bombay Branch of the Royal Asiatic Society.
1890: *Bendegó River:* by the Director of the National Museum, Rio de Janeiro.
1891: *Dundrum:* by the Board of Trinity College, Dublin.
1891: *Farmington:* by Mr. G. F. Kunz.
1891–1903: *Barratta* and *Thunda:* by Prof. A. Liversidge, F.R.S.
1894: *Makariwa:* by Prof. G. H. F. Ulrich.
1894: *Bherai:* by the Nawab of Junagadh, India.
1895: *Concepcion:* by Mr. W. Taylor.
1896: *Madrid:* by Don Miguel Merino of Madrid.

1897 : *Cold Bokkeveld:* by Mrs. Whitwell.
1899 : *Caperr:* by Dr. F. P. Moreno.
1899 : *El Ranchito* (Bacubirito) : by Mr. O. H. Howarth.
1899 : *Kokstad:* by the Trustees of the South African Museum.
1899 : *Zomba:* by Sir A. Sharpe, C.B., K.C.M.G., Mr. J. F. Cunningham, and Mr. J. McClounie.
1901 : *Ness City:* by Dr. H. A. Ward.
1903 : *Caratash:* by His Highness Kiamil Pasha.

Since the same year (1863) meteoritic exchanges have been made with the museums of Belgrade, Berlin, Blömfontein, Breslau, Calcutta, Cambridge, Chicago (Field Columbian Museum), Christiania, Debreczin, Dresden, Fremantle, Göttingen, Helsingfors, Odessa, Paris, Pau, Rio de Janeiro, Rome, St. Petersburg (Institute of Mines), South Africa, Stockholm, Sydney, Transylvania, Troyes, Utrecht, Vienna, Washington, Wisconsin University, and Yale College; and also with the following:—Dr. Abich of Dorpat, Dr. J. Auerbach of Moscow, Mr. S. C. H. Bailey of Cortlandt-on-Hudson, U.S.A., Prof. Baumhauer of Haarlem, Mr. C. S. Bement of Philadelphia, U.S.A., Dr. Breithaupt of Freiberg, Dr. A. Brezina of Vienna, Mr. J. R. Gregory of London, Prof. C. T. Jackson of Boston, U.S.A., Mr. Henry Ludlam of London, Prof. W. Mallet of Virginia, U.S.A., Prof. Vom Rath of Bonn, Prof. C. U. Shepard of New Haven, U.S.A., His Excellency Julien de Siemachko of St. Petersburg, Prof. Lawrence Smith of Louisville, U.S.A., Mr. J. N. Tilden of New York, U.S.A., and Dr. Henry A. Ward of Chicago, U.S.A.

In this way, by the generosity and self-denial of donors, by the somewhat difficult method of exchange, and by purchase, it has been possible to get together the fine representative collection of meteorites now in the British Museum.

AN INTRODUCTION

TO THE

STUDY OF METEORITES.

Most of the specimens here referred to are in Case 4 in the Pavilion at the end of the Mineral Gallery.

The fall of stones from the sky formerly discredited.

1. Till the beginning of the nineteenth century, the fall of stones from the sky was an event, the actuality of which neither men of science nor people in general could be brought to credit. Yet such falls have been recorded from the earliest times, and the records have occasionally been received as authentic by a whole nation. In most cases, however, the witnesses of such an event have been treated with the disrespect usually shown to reporters of the extraordinary, and have been laughed at for their supposed delusions: this is less to be wondered at when we remember that the witnesses of the arrival of a stone from the sky have usually been few in number, unaccustomed to exact observation, frightened both by what they saw and what they heard, and have had a common tendency towards exaggeration and superstition.

Ancient records.

2. De Guignes in his Travels states that, according to old Chinese manuscripts, falls of stones have again and again been observed in China; the earliest mentioned is one which happened about 644 B.C.

A stone, famous through long ages,* fell in Phrygia and

* Remarks concerning stones said to have fallen from the clouds both in these days and in ancient times: by Edward King. London, 1796. Mémoire historique et physique sur les chutes des pierres: par P. M. S. Bigot de Morogues. Orléans, 1812.

was preserved there for many generations. About 204 B.C. it was demanded from King Attalus and taken with great ceremony to Rome. It is described as "a black stone, in the figure of a cone, circular below and ending in an apex above."

In his History of Rome, Livy tells of a shower of stones on the Alban Mount, about 652 B.C., which so impressed the Senate that a nine days' solemn festival was decreed; as the shower lasted for two days, it was doubtless the result of volcanic action; other instances of the "rain of stones" in Italy, mentioned by the same author, had possibly a similar origin.

Plutarch relates the fall of a stone in Thrace about 470 B.C., during the time of Pindar, and according to Pliny, the stone was still preserved in his day, 500 years afterwards. The latter records two other falls, one in Asia Minor, the other in Macedonia.

Worship of meteoric stones.

3. These falls from the sky, when credited at all, have been deemed prodigies or miracles, and the stones have been regarded as objects for reverence and worship. It has even been conjectured that the worship of such stones was the earliest form of idolatry. The Phrygian stone, mentioned above, was worshipped at Pessinus by the Phrygians and Phœnicians as Cybele, "the mother of the gods," and its transference to Rome followed the announcement by an oracle that possession of the stone would secure to the State a continual increase of prosperity. Similarly, the Diana of the Ephesians, "which fell down from Jupiter," and the image of Venus at Cyprus, appear to have been, not statues, but conical or pyramidal stones. A stone, of which the history goes back far beyond the seventh century, is still revered by the Moslems as one of their holiest relics, and is preserved at Mecca built into the north-eastern corner of the Kaaba. The late Paul Partsch,* for many years Keeper of Minerals in the Imperial Museum of Vienna, considered that the meteoric origin of the Kaaba stone was sufficiently proved by descriptions which had been submitted to him. A stone which fell in Japan about

* Sitzungsber. d. k. Ak. d. Wiss. Wien. 1856, vol. 22, p. 393.

the year 1730, and was presented to the British Museum in 1883, had long been made an annual offering in a temple of Ogi at one of the Japanese religious festivals. It may be added that a stone which lately fell in India* was decked with flowers, daily anointed with ghee (clarified butter), and subjected to frequent ceremonial worship and coatings of sandal-wood powder. The stone was placed on a terrace constructed for it at the place where it struck the ground, and a subscription was made for the erection of a shrine. Pane 4c.

The oldest undoubted meteoric stone still preserved.

4. The oldest undoubted sky-stone still preserved is that which was long suspended by a chain from the vault of the choir of the parish church of Ensisheim in Elsass, and is now kept in the Rathhaus of that town. The following is a translated extract from a document which was preserved in the church:— Pane 4c.

> "On the 16th of November, 1492, a singular miracle happened: for between 11 and 12 in the forenoon, with a loud crash of thunder and a prolonged noise heard afar off, there fell in the town of Ensisheim a stone weighing 260 pounds. It was seen by a child to strike the ground in a field near the canton called Gisgaud, where it made a hole more than five feet deep. It was taken to the church as being a miraculous object. The noise was heard so distinctly at Lucerne, Villing, and many other places, that in each of them it was thought that some houses had fallen. King Maximilian, who was then at Ensisheim, had the stone carried to the castle: after breaking off two pieces, one for the Duke Sigismund of Austria and the other for himself, he forbade further damage, and ordered the stone to be suspended in the parish church."

Scientific men begin to investigate the reports.

5. Three French Academicians, one of whom was the afterwards renowned chemist Lavoisier, presented to the Academy in 1772 a report on the analysis of a stone said to have been seen to fall at Lucé on September 13, 1768. As Pane 4c.

* Records of the Geological Survey of India. Calcutta, 1885, vol. 18, p. 237.

the identity of lightning with the electric spark had been recently established by Franklin, they were in advance convinced that "thunder-stones" existed only in the imagination; and never dreaming of the existence of a "sky-stone" which had no relation to a "thunder-stone," they somewhat easily assured both themselves and the Academy that there was nothing unusual in the mineralogical characters of the Lucé specimen, their verdict being that the stone was an ordinary one which had been struck and altered by lightning.

Chladni argues that the bodies come from outer space.

6. In 1794 the German philosopher Chladni, famed for his researches into the laws of sound, brought together numerous accounts of the fall of bodies from the sky, and called the attention of the scientific world to the fact that several masses of iron, of which he specially considers two, had in all probability come from outer space to this planet.*

The Pallas iron.

One of them is the mass still known as the Pallas or Krasnojarsk iron.† This irregular mass, weighing about 1500 lbs., of which the greater part is in the Museum at St. Petersburg, was met with at Krasnojarsk by the traveller Pallas in the year 1772, and had been found in 1749 by a Cossack on the surface of the highest part of a lofty mountain between Krasnojarsk and Abakansk in Siberia, in the midst of a schistose district: it was regarded by the Tartars as a "holy thing fallen from heaven." The interior is composed of a ductile iron, which, though brittle at a high temperature, can be forged either cold or at a moderate heat; its large sponge-like pores are filled with an amber-coloured olivine; the texture is uniform, and the olivine equally distributed; a vitreous varnish had preserved it from rust. The fragment in the case, weighing about 7 lbs., was presented to the Trustees in 1776 by the Academy of Sciences of St. Petersburg. Pane 4c.

The Otumpa iron.

A second specimen referred to is that which in 1783 Don Michael Rubin de Celis was sent by the Viceroy of Rio de la Separate stand.

* Ueber den Ursprung der von Pallas gefundenen und anderer ihr ähnlicher Eisenmassen. Riga, 1794.

† Reise durch verschiedene Provinzen des russischen Reichs: von P. S. Pallas. St. Petersburg, 1776, Part III., p. 411.

Plata to investigate; * it had been found by Indians, searching for honey and wax, and trusting to rain for drink, projecting about a foot above the ground near a place called Otumpa, in the Gran Chaco Gualamba, South America, and was at first thought to be the outcrop of an iron vein. Don Rubin de Celis estimated the weight of this mass of malleable iron at thirty thousand pounds, and reported that for a hundred leagues around there were neither iron mines nor mountains nor even the smallest stones, and that owing to the absence of water, there was not a single fixed habitation in the country. There were several smaller masses at the locality; one of them, weighing 1400 lbs., is shown on a separate stand in the Pavilion: according to Sir Woodbine Parish, who presented it to the Museum in 1826, it had been removed to Buenos Ayres at the beginning of the struggle for Independence; it was a complimentary gift to Sir Woodbine on the occasion of his being sent by Canning to acknowledge the Independence of the State. A slice of this iron is shown in case 4*c*. Pane 4*c*.

Chladni's arguments. 7. Chladni argued that these masses could not have been formed in the wet way, for they had evidently been exposed to fire and slowly cooled: that the absence of scoriæ in the neighbourhood, the extremely hard and pitted crust, the ductility of the iron, and, in the case of the Siberian mass, the regular distribution of the pores and olivine, precluded the idea that they could have been formed where found, whether by man, electricity, or an accidental conflagration: he was driven to conclude that they had been formed elsewhere, and projected thence to the places where they were discovered; and as no volcanoes had been known to eject masses of iron, and as, moreover, no volcanoes are met with in those regions, he held that the specimens referred to must have actually fallen from the sky. Further, he sought to show that the flight of a heavy body through the sky is the direct cause of the luminous phenomenon known as a fire-ball.

The fall of stones at Siena, in Tuscany. 8. About seven o'clock on the evening of June 16, 1794, as if to direct attention to Chladni's just published theory, there fell a shower of stones at Siena, in Tuscany. Pane 4*c*.

* Philosophical Transactions. London, 1788, vol. 78, part 1, pp. 37, 183.

The event is described in the following letter, dated Siena, July 12, 1794, from the Earl of Bristol to Sir William Hamilton, K.B., F.R.S., at that time British Envoy-Extraordinary and Plenipotentiary at the Court of Naples:—*

"In the midst of a most violent thunderstorm, about a dozen stones of various weights and dimensions fell at the feet of different persons, men, women and children. The stones are of a quality not found in any part of the Siennese territory; they fell about 18 hours after the enormous eruption of Mount Vesuvius: which circumstance leaves a choice of difficulties in the solution of this extraordinary phenomenon. Either these stones have been generated in this igneous mass of clouds which produced such unusual thunder, or, which is equally incredible, they were thrown from Vesuvius, at a distance of at least 250 miles: judge, then, of its parabola. The philosophers here incline to the first solution. I wish much, Sir, to know your sentiments. My first objection was to the fact itself, but of this there are so many eyewitnesses, it seems impossible to withstand their evidence."

The fall of a stone near Wold Cottage, Yorkshire.

9. Soon afterwards there fell a stone in England itself. Pane 45. About three o'clock in the afternoon of December 13, 1795, a labourer working near Wold Cottage, a few miles from Scarborough, in Yorkshire,† was terrified to see a stone fall about ten yards from where he was standing. The stone, weighing 56 lbs., was found to have gone through 12 inches of soil and 6 inches of solid chalk rock. No thunder, lightning, or luminous meteor accompanied the fall; but in the adjacent villages there was heard an explosion likened by the inhabitants to the firing of guns at sea, while in two of them the sounds were so distinct of something singular passing through the air towards Wold Cottage, that five or six people went to see if anything extraordinary had happened to the house or grounds. No stone presenting

* Philosophical Transactions. London, 1795, vol. 85, p. 103.
† *Ibid.*, 1802, vol. 92, p. 174.

the same characters was known in the district. The stone is preserved in the Museum Collection. Pane 4*b*.

Terrestrial origin still sought for.

10. It seemed to be now impossible for any one to doubt the fall of stones from the sky, but the reluctance of scientific men to grant an extra-terrestrial origin to them is shown by the theories referred to in the above letter to Sir William Hamilton, and is rendered even more evident by the theory proposed in 1796 by Edward King, who suggested that the stones had their origin in the condensation of a cloud of ashes, mixed with pyritical dust and numerous particles of iron, coming from some volcano. As the stones fell at Siena out of a cloud coming from the North, while Vesuvius is really to the South, he gravely suggested that in this case the cloud had been blown from the South past Siena, and had then before its condensation into stone been brought back by a change of wind. As to the fall of a stone near Wold Cottage, he was not prepared either to believe or disbelieve the witnesses until the matter had been more closely examined; but in case the statements should prove worthy of credit, he points out the possibility of the necessary dust-cloud having come from Mount Hecla in Iceland.

The fall of stones near Benares, in India.

11. Later came a well-authenticated account of a more wonderful event still. At 8 o'clock on the evening of December 19, 1798, many stones fell at Krakhut, 14 miles from Benares, in India; the sky was perfectly serene, not a cloud had been seen since December 11, and none was seen for many days after. According to the observations of several Europeans, as well as natives, in different parts of the country, the fall of the stones was preceded by the appearance of a *ball of fire*, which lasted for only a few instants, and was followed by an explosion resembling thunder. Pane 4*c*.

Examination of stones by Howard.

12. Fragments of the stones of Siena, Wold Cottage, and Krakhut, as also of a stone said to have fallen on July 3, 1753, at Tabor, in Bohemia, came into the hands of Edward Howard, and the comparative results of a chemical and mineralogical investigation (the latter by the Count de Bournon) of the stones from the above four places are

given in a paper read before the Royal Society of London, on February 25, 1802. Howard concludes as follows:—

"The mineralogical descriptions of the Lucé stone by the French Academicians, of the Ensisheim stone by M. Barthold, and of stones from the above four places (Siena, Wold Cottage, Krakhut and Tabor) by the Count de Bournon, all exhibit a striking conformity of character common to each of them, and I doubt not but the similarity of component parts, especially of the malleable alloy, together with the near approach of the constituent proportions of the earth contained in each of the four stones, will establish very strong evidence in favour of the assertion that they have fallen on our globe. They have been found at places very remote from each other, and at periods also sufficiently distant. The mineralogists who have examined them agree that they have no resemblance to mineral substances properly so called, nor have they been described by mineralogical authors." Pane 4c.

Could projectiles reach the earth from the moon?

13. This paper aroused much interest in the scientific world, and, though Chladni's view that such stones come from outer space was still not generally accepted in France, it was there deemed more worthy of consideration after Poisson* (following Laplace) had shown that a body shot from the moon in the direction of the earth, with an initial velocity of 7592 feet a second, would not fall back upon the moon, but would actually, after a journey of sixty-four hours, reach the earth, upon which, neglecting the resistance of the air, it would fall with a velocity of about 31,508 feet a second.

The fall of stones at L'Aigle, in France.

14. Whilst the minds of the scientific men of France were in this unsettled condition, there came a report that still another shower of stones had fallen, this time in their own country, and within easy reach of Paris. To settle the matter finally, if possible, the physicist Biot, Member of the French Academy, was directed by the Minister of the Interior to inquire into the event upon the spot. After a careful Pane 4c.

* Bulletin des Sciences par la Société Philomathique. Paris, 1803, vol. 3, no. 71, p. 180.

examination of the stones and a comparison of the statements of the villagers, Biot* was convinced that—

1. On Tuesday, April 26, 1803, about 1 P.M., there was a noise as of a violent *explosion* in the neighbourhood of L'Aigle, in the department of Orne, followed by a rolling sound which lasted for five or six minutes: the noise was heard for a distance of 75 miles round.
2. Some moments before the explosion at L'Aigle, a *fire-ball* in quick motion was seen from several of the adjoining towns, though not from L'Aigle itself.
3. There was absolutely no doubt that on the same day *many stones fell* in the neighbourhood of L'Aigle.

Biot estimated the number of the stones at two or three thousand; they fell within an ellipse of which the larger axis was 6·2 miles, and the smaller 2·5 miles; and this inequality might indicate not a single explosion but a series of them. With the exception of a few little clouds of ordinary character, the sky was quite clear.

The exhaustive report of Biot, and the completeness of his proofs, compelled the whole of the scientific world to recognise the fall of stones on the earth from outer space as an undoubted fact.

The times and places of fall are independent of terrestrial circumstances.

15. Since that date many falls have been observed, and the attendant phenomena have been carefully investigated. These observations teach us that *meteorites*, as they are now called, fall at all times of the day and night, and at all seasons of the year, while they favour no particular latitudes: also they are found to be quite independent of the weather, and in many cases have fallen when the sky has been perfectly clear; even where stones have fallen in what has been called a thunder-storm, we may reasonably suppose that in most cases the luminous phenomenon has been mistaken for a variety of lightning, and the loud noise for thunder.

Velocity of meteorites.

16. From observations of the path and the time of flight of the luminous meteor, it is calculated that meteorites enter the earth's atmosphere with absolute velocities ranging

* Mémoires de l'Institut National de France. 1806, vol. 7, part 1, Histoire, p. 224.

from 10 to 45 miles a second: the velocity actually observed is that relative to a person at rest on the earth's surface; for the determination of the absolute velocity of the meteorite, the motion of the observer with the earth (about 18 miles a second) must be allowed for. Let us attempt to follow the course of a small compact body moving at such a rate. So long as the body is traversing "empty space," the only heat it receives is that sent direct from the sun and stars; in general, the meteorite will thus be probably very cold, and, owing to its small size and want of luminosity, it will be invisible to an observer on the earth's surface. After the meteorite enters the earth's atmosphere a very speedy change must take place.

The resistance of the air.

Assuming the law of resistance of the air for a planetary velocity to be the same as that deduced from experiments with artillery, the astronomer Schiaparelli* has shown that if a ball of 8 inches diameter and $32\frac{1}{3}$ lbs. weight enter the atmosphere with a velocity of $44\frac{3}{4}$ miles a second, its velocity on arriving at a point where the barometric pressure is still only $\frac{1}{760}$-th of that at the earth's surface will have been already reduced to $3\frac{1}{6}$ miles a second. From this it is clear that the speed of the meteorite after the whole of the atmosphere has been traversed will be extremely small, and comparable with that of an ordinary falling body. From experiments made by Professor A. S. Herschel, it has been calculated that the velocity of the meteorite which fell at Middlesbrough, in Yorkshire, on March 14, 1881, was, on striking the ground, only 412 feet a second. From the depth of the hole (20 to 24 inches) made in stiff loam by the stone which fell at Hvittis, in Finland, on October 21, 1901, it has been estimated by Mr. Borgström that the meteorite had a velocity of 584 feet a second when it reached the earth. He further calculates that the stone would have acquired virtually the same velocity if it had been merely allowed to fall, from a position of rest, under the action of gravity, through an infinite atmosphere having the same density as at the earth's surface. In the case of the

* Principes de Thermodynamique: par Paul de Saint-Robert. Paris, 1870, p. 329.

Hessle fall, several stones fell on the ice, which was only a few inches thick, and rebounded without either breaking the ice or being broken themselves.

Transfor-mation of he energy.

17. Further, Schiaparelli pointed out that, in the case imagined by him, the energy already converted into heat would be sufficient to raise 198,400 pounds of water from freezing point to boiling point under the ordinary barometric pressure. The greater part of this heat is, no doubt, carried off by the air through which the meteorite passes; but still the wonder is, not that a meteorite is small on reaching the earth's surface, but that any of it is left to "tell the tale."

'he cloud, ›all of fire and trail.

This sudden generation of heat will cause fusion, and even luminosity, of the outer material of the meteorite, and in some cases a combustion of some of its constituents: the products of the thermal and mechanical action sufficiently account for the *cloud* from which the meteorite is generally seen to emerge as a ball of fire, and also for the visible trail often left behind. The ball of fire has often an apparent diameter larger even than that of the moon, and is sometimes too bright for the eye to gaze upon.

The neteorite is only uminous the first part of ts flight through the air.

18. Owing to the quick reduction of speed, the luminosity will be a feature of the higher, not the lower, part of the course. The Orgueil meteorite of May 14, 1864, was so high when luminous that, notwithstanding its almost easterly motion, it was seen over a space of country ranging from the Pyrenees to the north of Paris, a distance of more than 300 miles.

'he time of flight hrough he air is ery brief.

19. Next we may remark that the time of flight in the earth's atmosphere will be very short, and reckoned only by seconds. Even when the meteorite is wholly metallic, if we may judge from the time one end of a poker may be held in the hand whilst the other end is in the fire, the heat will not have had time to get far below the surface before the body will have reached the ground. Pane ·td.

he crust.

As a matter of fact, meteorites are almost invariably found to be covered with a *crust* or varnish, such as would be caused by strong heating, and its thinness shows the slight depth to which the heat has had time to penetrate;

in the case of the stones, the greater part of the suddenly heated superficial material must chip off and be left behind at all parts of the track of the meteor. The aspect of the crust varies according to the mineral constitution of the meteorites: it is generally black, and in most cases dull, as in High Possil, Zsadány and Orgueil, but sometimes shiny, as in Stannern, or partly dull and partly shiny, as in Dyalpur; rarely, it is of a dark grey colour, as in Mezö-Madaras and some of the stones which fell in the neighbourhood of Mocs. In the case of the Pultusk meteorite of January 30, 1868, several thousands of stones, varying from the size of a man's head to that of a small nut, were picked up, each covered with a crust: fifty-six of the stones of this fall are shown in the case.

Pane 4*d*.

Panes 4*efg*.

The crust is not of equal thickness at every point; for, the form of the meteorite being a result of oft-repeated fracture, the constantly changing surface must be very irregular, and its different parts must be heated to different temperatures and be exposed to different amounts of mechanical action. Sometimes, owing to the motion of the meteorite through the air, the crust is so marked as to indicate the position of the meteorite in regard to its line of motion at a certain part of its course; and this relation is rendered more clear in some cases by evidence that melted material has been driven to the back of the moving mass. The Nedagolla iron and the Goalpara stone illustrate this peculiarity.

Pane 4*h*.

The pittings.

21. Further, the surface of a meteorite is generally covered with *pittings*, which have been compared in form to thumb-marks: stones from the Supuhee, Futtehpur, and Knyahinya falls present good examples of this character. It is remarkable that pittings bearing a close resemblance to those of meteorites have been observed on the large partially burned grains of gunpowder, which have been picked up near the muzzle after the firing of the 35-ton and 80-ton guns at Woolwich. The pitting of the gunpowder grains is attributed to unequal combustion, but that of meteorites seems to be due not so much to inequality of combustibility as to that of conductivity, fusibility and frangibility of the matter at the surface.

Pane 4*h*.

Pane 4*h*.

Fragmentary form of meteorites. **22.** As picked up, complete and covered with crust, meteorites are not spherical, nor have they any definite shape: in fact, they are always irregular angular fragments, such as would be obtained on breaking up a rock presenting no regularity of structure.

In the case of the Butsura fall of May 12, 1861,* fragments of the stone were picked up three or four miles apart, and, wonderful to say, it was possible to reconstruct Pane 4*h*. with much certainty the portion of the meteorite to which they once belonged: a model of the reconstructed portion is shown in the case. Two of the fragments, in other respects Pane 4*a*. fitting perfectly together, are even on the faces of the junction now coated with a black crust, showing that one disruption took place when the meteorite had a high velocity; two other fragments found some miles apart fitted perfectly, and were neither of them incrusted at the surface of fracture, thus indicating another disruption at a time when the velocity of the meteorite had been so far reduced that the material of the new faces was not blackened through the generation of heat. Sometimes, as in the case of the meteorite of Orgueil, the fragments reach the ground before the detonation is heard, proving that the fracture has taken place at a part of the course where the velocity of the meteorite was considerably greater than that of the sound-vibrations (1100 feet a second).

The detonations. **23.** The sudden condensation of air in front of the meteorite, the consequent generation of heat and expansion of the outer shell, have been held to account not only for the *break-up* of the meteorite into fragments, but partly also for the *crash like that of thunder* which is a usual accompaniment of the fall. Others have referred this noise solely to the sudden rush of air into the space traversed by the meteorite in the early part of the course. It has, however, now been discovered that the mere flight of a projectile through the air with a velocity exceeding that of sound (1100 feet a second) is itself sufficient to cause a loud detonation; neither explosion like that of a bomb-shell

* The Fall of Butsura: by Prof. Maskelyne. Phil. Mag. 1863, vol. 25, p. 50.

nor simple fracture of the meteorite by reason of pressure or sudden heat, is a necessary preliminary to the production of the loud noise. It is found, in fact, that when a projectile is fired with high initial velocity, say 2350 feet a second, an observer near the path of the projectile begins to distinguish two detonations as soon as his distance from the cannon reaches 500 feet; the first of them, a sharp one, appears to come from that part of the projectile's path which is nearest to the observer, and travels with the velocity of the projectile; the later and duller one appears to come from the cannon itself, and travels with the velocity of sound. If the projectile is intercepted near the cannon, only a single detonation is heard by an observer in the same position as before, and it travels at the rate of 1100 feet a second. If the initial velocity of the projectile is less than that of sound, only a single detonation is heard, and it starts from the cannon.

The rolling sound, which follows the detonation of a meteorite, is due, as in the case of thunder, to echoes from the ground and the clouds.

The detonations due to the different members of a swarm of meteorites will combine to form a single detonation unless they are separated by perceptible intervals of time.

The sounds heard after the loud detonations.

24. After the detonation, sounds are generally heard which have been variously likened to the flapping of the wings of wild geese, the bellowing of oxen, Turkish music, the roaring of a fire in a chimney, the noise of a carriage on the pavement, and the tearing of calico: these sounds are probably due to the whirling and oscillation of the fragments while traversing the air, with small velocity, near the observers, and correspond to the hiss or hum observed in the case of a projectile travelling with a velocity less than that of sound.

The chemical elements found in meteorites.

25. As to the *kinds of elementary matter** of which meteorites are composed, about one-third, and those the most common, of the elements at present recognised as

* Die chemische Natur der Meteoriten: von C. Rammelsberg. Berlin, 1870–9. Météorites: par S. Meunier. Paris, 1884. Meteoritenkunde: von E. Cohen. Stuttgart, 1894–1903.

constituents of the earth's crust have been met with: no new elementary body has been discovered.

The most frequent or plentiful in their occurrence are:—

Aluminium	Nickel
Calcium	Oxygen
Carbon	Phosphorus
Iron	Silicon
Magnesium	Sulphur:

while, less frequently or in smaller quantities, are found:

Antimony	Manganese
Arsenic	Nitrogen
Chlorine	Potassium
Chromium	Sodium
Cobalt	Strontium
Copper	Tin
Hydrogen	Titanium
Lithium	Vanadium.

Elements present only in minute quantity.

26. In addition to the above, the existence of minute traces of several other elements has been announced; of these special mention may be made of gallium, gold, iridium, lead, platinum and silver.

Both simple and combined.

27. All the elements are present in the combined state; the iron occurring chiefly as an alloy with nickel, and the phosphorus almost always combined with both nickel and iron. Some of them are found also in their elementary condition: perhaps hydrogen and nitrogen; carbon, both as indistinctly crystallised diamond and as graphitic carbon, the latter being generally amorphous, but occasionally in cubic crystals (cliftonite); free phosphorus has been found in Saline Township; free sulphur has been observed in one of the carbonaceous meteorites, but may have been separated from the unstable sulphides since the entry into our atmosphere.

Some of the constituents are new to mineralogy.

28. Of the constituents of meteorites, the following are by many mineralogists regarded as being at present unrepresented among the terrestrial minerals:— Pane 4*k*.

Cliftonite, a cubic form of graphitic carbon,
Phosphorus,
Various alloys of nickel and iron,

Schreibersite, phosphide of iron and nickel,
Troilite, proto-sulphide of iron,
Oldhamite, sulphide of calcium,
Osbornite, oxy-sulphide of calcium and titanium or zirconium,
Daubréelite, sulphide of iron and chromium,
Lawrencite, protochloride of iron,
Cohenite, a carbide of iron and nickel,
Asmanite, a species of silica,
Maskelynite, a singly refracting mineral with the composition of labradorite.

Nature of troilite, asmanite and maskelynite.

Of the above, *Troilite* is perhaps identical with some varieties of terrestrial pyrrhotite: *Asmanite*, the form of silica obtained in 1867 by Prof. Maskelyne from the Breitenbach meteorite, was announced by him in 1869 to be optically biaxal, and thus to belong to a crystalline system different from the hexagonal to which both tridymite, then just announced by Vom Rath, and quartz had been assigned. Later investigations of tridymite have shown that its optical characters and crystalline form are inconsistent with the hexagonal system of crystallisation, and it is not impossible that asmanite and tridymite may be specifically identical. It has been found that tridymite becomes optically uniaxal at a moderate temperature, and its general characters appear to be essentially identical with those of asmanite. According to one view, *Maskelynite* is the result of fusion of a plagioclastic felspar; according to another, it is an independent species chemically related to leucite.

Compounds identical with terrestrial minerals.

29. Other compounds are present, corresponding to the following terrestrial minerals:— Pane 4*k*.

Olivine and forsterite,
Enstatite and bronzite,
Diopside and augite,
Anorthite, labradorite and oligoclase,
Leucite,
Magnetite and chromite,
Pyrites,
Pyrrhotite,
Breunnerite.

Further, from one of the Lancé stones, chloride of sodium, and from the carbonaceous meteorites, sulphates of sodium, calcium and magnesium, have been extracted by means of water.

In addition to the above, there are several compounds or mixtures of which the nature has not yet been satisfactorily ascertained.

The rarity of quartz.

30. Quartz, the most common of terrestrial minerals, is absent from the stony meteorites; but in the undissolved residue of the Toluca iron microscopic crystals have been found, some of which have important characters identical with those of quartz, while others resemble zircon. As mentioned above, free silica is found in the Breitenbach meteorite as asmanite.

The conditions under which these compounds can have been formed.

31. As to the *conditions** under which such compounds can have been formed, we may assert that they must have been very different from those which at present obtain near the earth's surface: in fact, it is impossible to imagine that phosphorus, the metallic nickel-iron and the unstable sulphides can either have been formed, or have remained unaltered, under circumstances in which water and atmospheric air have played any prominent part. Still, what little we do know of the inner part of our globe does not shut out the possibility of the existence of similar elementary and compound bodies at great depths below the surface. Daubrée,† after experiment, inclines to the belief that the iron is due, in many cases at least, to reduction from an olivine rich in diferrous silicates, and this view perhaps acquires some additional probability from the fact that hydrogen and carbonic oxide are given off when meteoric iron is heated: the existence, however, of such siderolites as that of Krasnojarsk, which is rich both in metallic iron and in orthosilicate of iron and magnesium (olivine), and yet presents no traces of the intermediate metasilicate of iron and magnesium (bronzite), offers a weighty objection to the general application of this view.

* Some lecture-notes on meteorites: by Prof. Maskelyne. *Nature*, 1875, vol. 12, pp. 485, 504, 520.

† Études synthétiques de géologie expérimentale. Paris, 1879, p. 517.

Classification.

32. Meteorites may be conveniently arranged in three classes, which pass more or less gradually into each other: the first includes all those which consist mainly of iron, and have, therefore, been called by Prof. Maskelyne aero-siderites (*aer*, air, and *sideros*, iron), or, more shortly, *Siderites;* the second is formed by those which are composed chiefly of iron and stone, both in large proportion, and are called aero-siderolites, or, shortly, *Siderolites;* while those of the third class, being almost wholly of stone, are called *Aerolites* (*aer*, air, and *lithos*, stone).

The siderites.

33. In the Siderites the iron generally varies from 80 to 95 per cent., and the nickel from 6 to 10 per cent.; in the Santa Catharina siderite (of which the meteoric origin is somewhat doubtful) 34, and in that of Oktibbeha County 60, per cent. of nickel have been found: the nickel is alloyed with the iron, and several of the alloys have been distinguished by special names. Owing to the presence of the nickel, meteoric iron is often so white on a fractured surface as to be mistaken for silver by its finder; it is also less liable to rust than ordinary iron is. Troilite is frequently present as veins or large nodules, sometimes surrounded by graphite; schreibersite is almost always found, and occasionally also daubréelite.

Evolution of gases on heating.

Further, various chemists have proved that hydrogen, nitrogen, marsh gas, and the carbonic oxides are evolved when meteoric iron or stone is heated; in one case a trace of helium was detected. Probably the gases were not present in the occluded state, but resulted from the decomposition or interaction of non-gaseous constituents during the experiments.

Figures produced by action of acids or bromine.

34. The want of homogeneity and the structure of meteoric iron are beautifully shown by the figures generally called into existence when a polished surface is exposed to the action of acids or bromine; they are due to the inequality of the action on the various constituents, and the layers are composed chiefly of kamacite and of tænite, alloys of nickel and iron. In the Agram iron, investigated by Widmanstätten in 1808, the layers are parallel to the faces of the regular octahedron; such figures are well shown Pane 4.

by the exhibited slice of the Toluca iron; different degrees of distinctness of such "Widmanstätten" figures are illustrated by specimens of Seneca River, Zacatecas, Charcas, Burlington, Jewell Hill, Lagrange, Victoria West, Nelson County, and Seeläsgen. The large Otumpa specimen, mounted on a separate pedestal, furnishes a good example of the less distinct, and more or less damascene, appearance presented by the etched surface of some meteoric irons of octahedral structure. The Braunau iron has cleavages parallel to the faces of a cube, and on etching yields linear furrows which were found (1848) by Neumann to have directions such as would result from twinning about an octahedral face; as illustrations of the "Neumann" figures, etched specimens of Braunau and Salt River are exhibited.

Pane 4*l*.

Pane 4*l*.

Few siderites have been seen to fall.

35. The Siderites *actually observed to fall*, or found soon afterwards, reach only the small number of ten; they are, Agram, Charlotte, Braunau, Victoria West, Nedagolla, Rowton, Mazapil, Cabin Creek, Bugaldi, and N'Goureyma. The remaining specimens in collections of Siderites are presumed to be of meteoric origin by reason of the peculiarity of their appearance and chemical composition, and of the locality in which they have been found (Art. **7**). The two largest known were found in West Greenland and Mexico respectively, and are both of very irregular shape. The Greenland mass is 11 feet long, 7½ feet wide, and 6 feet thick, and its weight has been variously estimated at from 50 to 100 tons; the mass had long been known to the Esquimaux, and was inquired after by Captain John Ross in 1818; it was shown by a native to Lieutenant Peary in 1894, who afterwards transported it from Melville Bay to New York. The Mexican mass is 13 feet long, 6 feet wide, and 5 feet thick, and has an estimated weight of 50 tons; it is the property of the Mexican Government, and is still lying at El Ranchito, near Bacubirito, Province of Sinaloa.

The iron found at Ovifak is probably of terrestrial origin.

36. The difficulty of distinguishing an iron of terrestrial from one of meteoric origin has been lately rendered very evident by the controversy as to the origin of the large masses of iron, containing one or two per cent. of nickel, and weighing 9,000, 20,000, and 50,000 lbs. respectively, found

in 1870 by Baron N. A. E. Nordenskiöld on the beach at Ovifak, Disko Island, Western Greenland.

A careful examination of the rocks of the neighbourhood shows that the basalt contains nickeliferous iron disseminated through it, and that the large masses of iron, at first thought to be meteorites, are very probably of terrestrial origin, and have been left exposed upon the seashore, through the weathering of the rock which originally enclosed them. Part of a mass extracted from the rock by Baron Nordenskiöld in 1870, and presented by him to the Trustees, is shown on a table in the Pavilion. Malleable metallic nodules extracted from the rock itself were found to contain as much as 6·5 per cent. of nickel. In 1880 Professor K. J. V. Steenstrup* found ferriferous basalt *in situ* in three different parts of the island. At Assuk (Asuk) the enclosed balls of iron reach a diameter of nearly three-quarters of an inch. Some assert that the basalt and the nickel-iron have been expelled together from great depths below the earth's surface, while others consider that the nickel-iron is due to the reduction of the basalt by its passage through the beds of lignite and other vegetable matter found in the vicinity. Pane 4*m*.

Other terrestrial irons.

37. With the Ovifak iron in the case are shown other specimens of iron which have been brought by various explorers from West Greenland, and were formerly thought to have had a meteoric origin. The discovery of ferriferous basalt, not only *in situ* in several places, but also deposited in a Greenlander's grave (1879) along with knives (similar to those given to Captain John Ross in 1818) and the usual stone tools, renders it clear that the Esquimaux were not dependent solely on meteorites for their metallic iron, as had long been supposed. Pane 4*m*.

Mr. Skey announced in 1885 the discovery of terrestrial nickel-iron in New Zealand. Grains of the alloy (Awaruite), containing as much as 67·6 per cent. of nickel, are found in the sand of the rivers flowing from a range of mountains composed of olivine-enstatite rocks, in places altered to serpentine: similar particles have been found in the serpen-

* Mineralogical Magazine. London, 1884, vol. 6, p. 1.

tine itself. Similarly, in the sand of the stream Elvo, near Biella, in Piedmont, grains of nickel-iron containing 75 per cent. of nickel have been found: and in the placer gravel of a stream in Josephine and Jackson Counties, Oregon, U.S.A., large quantities of waterworn pebbles, which enclose an alloy (Josephinite) of nickel and iron containing 72 per cent. of the former metal, have been met with. Professor Andrews many years ago established the presence of minute particles of metallic iron in some basalts; Dr. Sauer has lately found a single nodule of malleable iron of the size of a walnut in the basalt of Ascherhübel, in Saxony, and Dr. Johnston-Lavis has announced the find of an enclosure of metallic iron in a leucitic lava of Monte Somma; Dr. Hoffmann has noted the occurrence of minute spherules of brittle iron both in perthite and quartzite in Ontario; Dr. Hussak has recorded the discovery of metallic iron in an alluvium of Brazil, and Dr. Högbom has found it associated with topaz, quartz, felspar, and other minerals, in limonite from an unspecified place in South America.

The stony matter of meteorites.

38. The stony part of the siderolites and aerolites is almost entirely crystalline, and in most cases presents a peculiar "chondritic" or granular structure, the loosely coherent grains being composed of minerals similar to those which enclose them, and containing in most cases minute particles of iron and troilite disseminated through them: glass-inclusions are found to be present. The minerals mentioned above as occurring in meteorites are such as are very characteristic of the more basic terrestrial rocks, such as dunite, lherzolite and basalt, which have been expelled from considerable depths below the earth's surface.

39. Several attempts to classify aerolites according to their mineralogical constitution have been made, but it cannot be said that any of them is very satisfactory; seeing that even in the same stone there may be much difference in its parts, a perfect classification on such a basis is scarcely to be hoped for.

Chondritic aerolites.

About eleven out of every twelve of the stony meteorites belong to a division to which Rose* gave the name of

* Beschreibung und Eintheilung der Meteoriten. Berlin, 1864.

chondritic (*chondros*, a grain): they present a very fine-grained but crystalline matrix or paste, consisting of olivine and enstatite or bronzite, with more or less nickel-iron, troilite, chromite, augite and anorthic felspar; through this paste are disseminated round chondrules of various sizes (up to that of a walnut) and with the same mineral composition as the matrix; in some cases the chondrules consist wholly or in great part of glass.* In mineral composition chondritic aerolites approximate more or less to terrestrial lherzolites. Some meteorites consist almost solely of chondrules, others contain only few; in some cases the chondrules are easy separable from the surrounding material. Of the chondritic division Knyahinya, Pegu, Muddoor, Seres, Judesegeri, Khiragurh, Utrecht and Nellore (pane 4*p*) afford good illustrations. Pane 4*n*.

A carbonaceous group.

A few meteorites belonging to this division are remarkable as containing carbon in combination with hydrogen and oxygen. Of these the Alais and Cold Bokkeveld meteorites are good examples: the former has a bituminous smell; it yields sulphates of magnesium, calcium, sodium and potassium, if steeped in water. Pane 4*n*.

Aerolites without chondrules.

40. The remaining aerolites are not chondritic, and they contain little or no nickel-iron; of these we may specially mention for their mineral composition the following:— Pane 4*o*.

Juvinas and *Stannern*, consisting essentially of anorthite and augite.

Petersburg, consisting of anorthite, augite and olivine, with a little chromite and nickel-iron: both Juvinas and Petersburg may be compared to terrestrial basalt.

Sherghotty, consisting chiefly of augite and maskelynite.

Angra dos Reis, consisting almost wholly of augite; olivine is present in small proportion.

Bustee, of diopside, enstatite and a little anorthic felspar, with some nickel-iron, oldhamite and osbornite.

Bishopville, of enstatite and anorthic felspar, with occasional augite, nickel-iron, troilite and chromite.

Roda, of olivine and bronzite.

* Die mikroskopische Beschaffenheit der Meteoriten: von G. Tschermak. Stuttgart, 1883–5.

Chassigny, consisting of olivine with enclosed chromite, and thus mineralogically similar to a terrestrial dunite.

Is there a periodic recurrence?

41. The importance of the examination and classification of meteorites, with a view to a possible recognition of *periodicity* of fall of specimens presenting the same characters, need only be mentioned to be appreciated: such a determination is, however, rendered very difficult by the close similarity of structure and composition presented by the great majority of the aerolites of the large chondritic division.

Few aerolites are known which have not been seen to fall.

Separate stand.

42. Attention has been already directed to the fact that although many meteoric irons, some of them like that of Cranbourne weighing several tons, have been found at various parts of the earth's surface, very few of them have been actually observed to fall: in the case of the stony meteorites just the opposite holds good, for they are never very large, and few are known which have not an authenticated date of fall. This may be due to the fact that a meteoric stone is less easily distinguished than is a meteoric iron from ordinary terrestrial bodies, and will thus in most cases remain unnoticed unless its fall has been actually observed; while, further, a quick decomposition and disintegration must set in on exposure to atmospheric influences. The smaller size of the meteoric stones may be due to the greater ease with which they break up on the sudden increase of temperature of their outer surface, consequent on their entry into the earth's atmosphere. The largest meteoric stone preserved in a Museum is one which fell as part of a shower at Knyahinya, Hungary, in 1866: it weighs 647 lbs. and is at Vienna. A larger stone (723 lbs.) fell at Tabory, Russia, in 1887, but was broken to pieces by the impact on the earth; fragments of a still larger single stone, weighing at least 1244 lbs., were found near together at Long Island, Kansas, U.S.A., but the fall was not observed.

The chondrules and their matrix.

43. If we now examine minutely the structure of the meteoric stones, it will be seen that almost all of them appear to be made up chiefly of irregular angular fragments, and that some of them bear a close resemblance to

volcanic tuffs. In the large group of chondritic aerolites, chondrules or spherules, some of which can only be seen under the microscope while others reach the size of a walnut, are embedded in a matrix, apparently made up of minute splinters such as might result from the fracture of the chondrules themselves. In fact, until recently, it was thought by some * that the chondrules owe their form, not to crystallisation, but to friction, and that the matrix was actually produced by the wearing down of the chondrules through collision with each other either as oscillating components of a comet or during repeated ejection from a volcanic vent of some small celestial body. Chondrules have been observed, however, presenting forms and crystalline surfaces incompatible with such a mode of formation, and others have been described which exhibit features resulting from mutual interference during their growth.

The crystallisation of the chondrules is independent of their form, and must have started, not at the centre, but at various places on their surfaces; Dr. Sorby † argues that some at least of the chondrules must once have fallen as drops of fiery rain, and have assumed their shape in an atmosphere heated to nearly their own temperature. The chondritic structure is different from anything which has been observed in terrestrial rocks, and the chondrules are distinct in character from those observed in perlite and obsidian. After much study, Dr. Brezina ‡ lends his weighty support to the hypothesis that the structural features of meteorites are the result of a hurried crystallisation: and Prof. Wadsworth § accepts the same interpretation.

Some meteoric materials appear to have been altered since their consolidation.

44. Since the time of their consolidation some meteoric stones, as Tadjera, appear to have been heated throughout their mass to a high temperature: and in the case of Orvinio, Chantonnay, Juvinas, and Weston, fragments are cemented together with a material having the same composition as Pane 4c.

* Pogg. Ann. 1858, vol. 105, p. 438: Phil. Mag. 1876, ser. 5, vol. 1, p. 497.

† On the structure and origin of meteorites. *Nature*, 1877, vol. 15, p. 495.

‡ Die Meteoritensammlung d.k.k.min.Hofkabinetes in Wien. 1885, p. 19.

§ Lithological Studies. Cambridge, U.S.A. 1884, p. 110.

the fragments themselves, thus giving rise to a structure resembling that of a volcanic breccia. Others seem to have experienced a chemical change, for some of the chondrules in Knyahinya and in Mezö-Madaras, when examined with the microscope, are found to be surrounded by spherical and concentric aggregations of minute particles of nickel-iron, perhaps due to the reducing action of hydrogen at a high temperature. Others, as Château-Renard, Pultusk, and Alessandria, present what in terrestrial rocks would probably be called faults: in some cases the fissures are seen to have been filled with a fused material after the chondrules have been broken and one side of the fissure has glided along the other. These peculiarities of structure suggest that the small body which reaches the earth is only a minute fragment of a much larger mass. It has been suggested that the chondritic structure is of metamorphic origin, and a mere result of enormous pressure on the stony material during the passage through the earth's atmosphere; according to still another view, the structure, though metamorphic, is of extra-terrestrial origin, and due to the quick cooling of a tuff-like stone which has been partially melted, for instance, by the heat from a neighbouring new star or by traversing the hot vapours on the limits of an old one.

Do meteorites reach our atmosphere as clouds of gas or dust?

45. The idea that meteorites arrive at our own atmosphere, not as fragments of rock, but as mere clouds of gas or dust, has been recently revived and again discarded According to this hypothesis, the air, instead of dispersing the entering cloud, acts in the contrary way, and in a few seconds of time presses the particles together to form solid bodies. This idea is open to various objections, and in any case one can scarcely understand how large masses of iron, presenting a wonderful regularity of crystalline structure, can have been the result of so hurried a process: and if we once grant that the irons enter the atmosphere as solid bodies, it is difficult to believe that the same is not the case with the stones.

Where do meteorites come from?

46. From the above it will be evident that the old hypotheses that meteorites are terrestrial stones which have been struck by lightning, or carried to the sky by a whirlwind, or are

concretions in the atmosphere, or are due to the condensation of a dust-cloud coming from some volcano, or have been shot recently from terrestrial volcanoes, are inconsistent with later observation; it may be granted that the bodies reach our atmosphere from outer space. From what part or parts of space do they come? Their general similarity of structure and chemical composition, and more especially the presence of nickeliferous iron in almost every one, suggest that most, if not all of them, have had a common source, and that they are chips of a single celestial body.

Probably not from the sun, nor from the moon, earth, or other planet.

47. Dr. Sorby holds that they are probably ejected from the sun itself, though this is difficult to reconcile with the fact that some of them are easily combustible. Others, among whom we may mention Laplace, have suggested that they come from volcanoes of the moon which are now active; but the suggestion, although mathematically sound, has no physical basis, for, so far as one can discover, active volcanoes do not there exist: and Sir Robert Ball* has virtually excluded the lunar volcanoes, which were active in times now long past, by pointing out that if a projectile from the moon once misses the earth, its chance of ever reaching the earth is too small to be worthy of mention. It has further been shown that, although the explosive force necessary to carry a projectile so far from one of the smaller planets that it will not return, is not very large, yet the initial velocity requisite to carry the body as far as the earth's orbit is so considerable, and the chance of hitting the earth so slight, that a more probable hypothesis is, to say the least, desirable. If these bodies have been shot from volcanoes of any planet, Sir Robert Ball is himself inclined, upon mechanical grounds alone, to believe that the projection was from our own in bygone ages; for as such projectiles, having once got away from the earth, would take up paths round the sun which would intersect the earth's orbit, every one of them would have a chance of some time or other meeting with the earth again at the point of intersection, and of appearing as a meteorite. The size and initial velocity requisite for the escape of a projectile through a lofty atmosphere would be enormous:

* Speculations on the source of Meteorites. *Nature*, 1879, vol. 19, p. 493.

even then the difficulty would still remain that meteorites generally differ, both in structure and material, from anything known to have been ejected from existing terrestrial volcanoes. To meet these difficulties, Sir Robert has speculatively suggested that the matter was expelled before the surface of the earth became solid, and at a time when there was as much activity in the terrestrial planet as there is now in the material of the sun itself.

Nor is it probable that they are portions of a lost satellite of the earth, or are due to a collision of two planets; for in each of these cases we should expect to have received some of the larger fragments which must at the same time have been produced.

Much light is thrown on the history of meteorites by the discovery of a relationship with shooting stars and comets.

Shooting or falling stars.

48. The meteorite-yielding fireball, referred to in Art. **17**, is not the only luminous meteor, apart from lightning, with which we are acquainted. On a clear dark night any one can see a star shoot now and then across the firmament: it is estimated that on the average as many as fourteen are visible to a single observer every hour. Are the *shooting*, or, as they are often called, *falling stars* products of our own atmosphere, or do they, like the meteorites, come from outer space? In 1794 Chladni, in the memoir already referred to, gave reasons for believing that a meteoritic fireball and a shooting star are only varieties of one phenomenon.

The November star-showers.

49. But long after the cosmic origin of meteorites had been generally acknowledged, the atmospheric origin of the shooting stars was still asserted, and it was not till the wondrous star-shower of November 12–13, 1833,* that the cosmic origin of any of the shooting stars was finally established. During that night upwards of 200,000 shooting stars, according to a rough estimate, were seen from a single place; and the remarkable observation was made at various localities, widely distributed over North America, that the apparent paths of the shooting stars in the sky, when prolonged backwards, all passed through a point in the

* *Olmsted.* American Jour. Sc., 1834, ser. 1, vol. 25, p. 363.

constellation Leo: this point of radiation appeared to rotate with the heavens during the eight hours for which the shower was visible.

Hence it was manifest that the star-shower was independent of the earth's rotation and must therefore have come from outer space; that the radiation of the paths was only apparent and due to perspective; and that, relatively to an observer, the flights of all the shooting stars were really parallel to the direction of the apparent radiant point.

On the same day of November in each of the three following years the shower was repeated though on a less grand scale, and the constancy of the radiant point was confirmed: similar small showers had been seen also in 1831 and 1832 before the radiation had been noticed. Though in the years immediately before and after 1831–6 no remarkable display of November meteors took place, it was remembered that a similar shower had been chronicled by Humboldt and by Ellicott, as observed by them on November 12, 1799; and a study of ancient documents revealed the fact that a grand star-shower had been recorded several times in October and November since A.D. 902, the date having gradually advanced, during that long space of time, from the middle of October to the middle of November.* The only sufficient explanation of the observed facts is that a swarm of isolated small bodies, solid and non-luminous—meteorites in fact—is moving in an orbit round the sun, completing the circuit in $33\frac{1}{4}$ years; the orbit intersects that of the earth, and the earth meets the swarm at the place of intersection. The isolated bodies or meteorites become luminous, as already explained in Art. 17, after their entry into the earth's atmosphere. The swarm can be only a few hundred thousand miles thick, for the earth, travelling through space at the rate of 66,000 miles an hour, passes through the densest part in 2 or 3 hours, and through the whole in 10 to 15 hours: its length, however, must be enormous, amounting to hundreds of millions of miles; for, although the meteorites move with a velocity of twenty miles a second, the swarm takes 5 or 6 years to pass the place of intersection with the earth's

* *Newton.* American Jour. Sc., 1864, ser, 2, vol. 37, p. 377; vol. 38, p. 53.

orbit, thus causing star-showers, more or less dense, during that number of years.

Contrary to expectation, no large November star-shower occurred either in the year 1899 or in the years which have since elapsed.

Schiaparelli has shown that the unequal attraction of the sun for the individuals of a swarm of meteorites moving round it would scatter them along the orbit, and in the course of time produce a more or less complete ring; if this intersects the earth's orbit an annual star-shower must ensue.

The August star-shower and its comet.

50. A small annual star-shower occurs, in fact, on August 10–11,* and has been observed since A.D. 830: it radiates from a point in the constellation Perseus. Schiaparelli calculated in 1866 the orbit and motion of the meteorites producing it, and was surprised to find that the numbers corresponded exactly with those calculated for one of the recently observed comets; in other words, a comet was moving in the path of the meteorites, and at exactly the same speed. At the same time Schiaparelli gave numbers defining the motions of the meteorites which would cause the periodic November star-showers.

Star-showers related to comets.

51. Immediately afterwards, when the numbers calculated by Oppolzer for the orbit of the comet discovered by Tempel were published, it was seen that they were really identical with those already calculated by Schiaparelli for the orbit of the meteorites of the November star-shower, and that here again a comet and a swarm of meteorites were moving in exactly the same path at exactly the same rate.

Almost immediately afterwards it was shown that the radiant points of the small star-showers of April 20–21 and November 27–28 both correspond to the orbits of known comets.

It was evident that these could not be accidental coincidences, and that the comets and the attendant swarms of meteorites are closely related to each other.

Comets.

52. An intimate connection between, if not complete identity of, meteorites, shooting stars and comets, had indeed long been suspected. Astronomers were convinced

* Report Brit. Assoc., 1868, p. 394.

that comets, though occasionally of enormous size, are always of extremely small mass, since they pass by the earth and other planets without sensibly disturbing their motions; the comet of 1770 passed through the system of Jupiter's satellites without any perceptible action upon them: it has been calculated that the mass of a small comet may be about eight pounds. Again, the light of a comet, like that of a cloud or planet, was seen to be partially polarised: hence part, at least, must be reflected sunlight, for the plane of polarisation passes through the sun's place. Further, stars of very small magnitude have been seen not only through the tail, but even through the nucleus, of a comet without any apparent alteration of position by refraction: hence it was inferred that a comet is not a continuous mass, but consists of particles so far distant from each other that a ray of light may pass through the comet without meeting a single one of them. Such a constitution likewise accounts for the absence of phases of the reflected light: for although only half of each particle will be directly illuminated by the sun, the remaining half will receive light irregularly reflected from the particles more distant from the sun.

Among others, Chladni in 1817 had referred to the great similarity in the motions of comets and meteorites: Olmsted, in 1834, had calculated the orbit of a comet which would cause the November star-shower; his results were wrong owing to the assumption that the shower was annual: Cappocci, in 1842, gave reasons for believing that a meteorite is a small comet: Reichenbach, in 1858, in a most elaborate paper,* sought to prove that a comet is a swarm of meteorites; that each chondrule of a meteorite had once been an individual of a cometary swarm, and owes its rounded shape to frequent collision with its fellows; that the rest of the stone consists of the broken splinters thus produced; and that the brecciated aspect of many meteorites is due to collisions in the denser part or nucleus of a comet. As already pointed out in Art. 43, later modes of investigation have led petrologists to reject this method of accounting for the rotundity of the chondrules.

* Pogg. Ann., 1858, vol. 105, p. 438.

Other star-showers.

53. In addition to the few radiant points which correspond to swarms moving in orbits identical with those of known comets, there are numerous radiant points which have not yet been recognised as related to existing comets, and may possibly be due to swarms produced by the dispersal of comets along their orbits; indeed, it has been inferred from observation of shooting stars that on the average there are no fewer than fifty distinct radiant points, and therefore showers, for any night of the year. But there are still others of which there is yet no satisfactory explanation. A cometary swarm is thin, and is passed through in a few hours; the stars are seen to radiate from the corresponding point of the sky for only that length of time: but there are other radiant points which have a duration of several months, and this is the case notwithstanding the constantly changing direction of the earth's motion in space.* Since the position of the radiant point in the sky as seen by a terrestrial observer depends not only on the direction in which the swarm is moving, but also on the velocity and direction of motion of the observer through space, it is easily seen that a radiant point having a fixed position during some months corresponds to something quite distinct from a cometary swarm. It has been suggested by Mr. W. F. Denning (1899) that in some cases a long-continued radiant point may really be due, not to a single swarm, but to successive swarms not physically associated with each other. On the other hand, Professor H. H. Turner has shown that the effect of the earth's attraction on a meteorite passing near it is to change only the *position* of the orbit of the meteorite, not the inclination to the earth's orbit or the relative speed; hence, a swarm of such meteorites must be spread out, in the course of ages, into a succession of rings, all of them equally inclined to the earth's orbit, but intersecting it at different places; the radiant point will then be of long duration. Professor A. S. Herschel † makes the suggestion that the radiant points of long duration may have resulted from the passage, in bygone epochs, of quickly moving streams of cosmical matter through

* Denning. *Nature*, 1885, vol. 31, p. 463.

† Monthly Notices of the Roy. Astron. Soc. 1899, vol. 59, p. 179.

a ring of small bodies circulating, as satellites, round the earth.

The breaking up of comets.

54. The history of Biela's comet* is of great interest as throwing light on the relationship of comets and swarms of meteorites. Though already observed in 1772 and in 1806, this comet was not recognised as periodic till it was seen by Biela in 1826, when its orbit was determined. On its returns in 1832 and 1845 it was found in its calculated positions, but in the latter year was seen to be double, a small comet being visible beside a larger one. Vast changes took place during the time the companions were visible. The smaller one grew both in size and brightness, each threw out a tail, the smaller threw out a second tail, afterwards the larger showed two nuclei and two tails, then the smaller became the brighter of the two companions; next three tails were shown by the primary, and three cometary fragments were visible round its nucleus. On the next return, in 1852, the two comets were farther apart, one being more than a million miles ahead of the other. The next favourable return was to be in 1866, and the orbit was by this time so well known that the positions of the two companions could be calculated beforehand with great precision; owing to the changes which had been visibly taking place, the arrival of the comets was looked forward to with great interest by astronomers. But neither in 1866, nor on the next occasion in 1872, were they to be seen in their calculated positions, and a careful examination of the whole sky failed to lead to their discovery.

The connexion between several comets and meteoritic swarms having in the meantime been established, it was now surmised that Biela's comet might have been scattered along part of its path, and that some evidence of the dispersal might perhaps be obtained on the next occasion, November 27, 1872, of the passage of the earth across the comet's orbit. In fact the star-shower of that date, with a radiant point corresponding to the orbit of Biela's comet, was observed to be much more dense than usual, the stars shooting across the sky at the rate of a thousand an hour for several hours.

* Newton. *Nature*, 1886, vol. 33, pp. 392, 418.

Passage of the earth through a comet.

55. Klinkerfues, a German astronomer, was struck with the idea that if this star-shower were really due to the passage of the earth through a moving swarm of meteorites, the latter might possibly be visible as it departed from our neighbourhood. The swarm having come from a radiant point in the northern sky, after passing the earth would need to be sought near the opposite point in the southern sky; he telegraphed, therefore, to the Madras observatory, asking Pogson, the astronomer, to search for the swarm in the direction opposite to the radiant point. The search was successful; on two mornings a small comet was distinctly seen, and on the second morning it showed a tail with an apparent length equal to one-fourth the apparent diameter of the moon. Bad weather came on, and the comet got away without being again seen. The two Madras observations agree with a motion in the orbit of Biela's comet, and show that the earth had passed excentrically through the small comet seen by Pogson. This small comet was probably a third fragment of Biela's, for it was 200 million miles behind the calculated position of the first two. From these two observations it is inferred that a swarm of meteorites, though only manifesting itself by a star-shower when passing through the earth's atmosphere, at some distance from us may be visible as a comet by reflected sunlight.

Fall of a meteorite during a star-shower.

56. A dense star-shower* recurred on the same day of the month (November 27) in 1885, the principal part being over in six hours. The hourly number visible at one place at the time of greatest density was estimated at 75,000. In the densest part of the stream, the average distance of the individuals from each other was about twenty miles.

During this star-shower a piece of iron weighing about 8 lbs. was seen to fall at Mazapil in Mexico:† in external characters and chemical composition it is similar to the other meteoric irons: the simultaneity was probably accidental.

The reason of its rarity.

57. It may be asked why, if star-showers are caused by the entry of solid bodies into our atmosphere from without, there is only one authentic instance of material being actually

* *Newton.* American Jour. Sc., 1886, ser. 3, vol. 31, p. 409.
† *Hidden.* American Jour. Sc., 1887, ser. 3, vol. 33, p. 223.

seen to fall and being picked up during such a shower. As it is absolutely beyond question that star-showers do come from outer space, we can seek an explanation only in the size or speed of the entering individuals, or in the nature of their material. A sufficient reason is to be found in the small size of the individuals; for the meteorites which actually reach the ground rarely weigh more than a few pounds, and are often quite minute; a small diminution of the original individual would thus ensure its complete destruction before the planetary velocity was exhausted: that the individuals of a swarm are extremely minute follows from the fact that the total mass of the biggest swarm is small, while the number of the individuals seems almost infinite.

Large and small luminous meteors essentially similar.

58. Between the small silent shooting star visible only with the telescope and the large detonating meteorite-yielding fireball there is every gradation; during the star-showers themselves many fireballs of great size and brilliancy are seen, while the smaller individuals appear in no way different from the solitary shooting star. The luminous meteors, large and small, are in the upper atmosphere, few higher than 100 miles, few lower than 30 miles from the earth's surface; they all have velocities of the same order of magnitude, comparable with that of the earth in its orbit; in each there must be a solid body, as is proved by the long path in the sky, for attendant gas or vapour would be immediately scattered or burnt; large and small present similar varieties of colour, and leave similar luminous trails; examination with the spectroscope teaches us that the light of the meteors is such as would result from the ignition of such meteorites as have actually reached the ground. The frequent absence of detonation may likewise be due in many cases to the small size, or small relative velocity, of the entering meteorite.

The light of a comet.

59. That part of the light of a comet is reflected sunlight is confirmed by examination with the spectroscope, in which instrument is seen a feeble continuous spectrum crossed by dark lines, identical with those afforded by the direct light of the sun. But a comet is also more or less self-luminous; for, in addition to the continuous spectrum, there are bright

flutings and bright lines to which much attention has been given. The three ordinary bright flutings were found by Sir Willian Huggins in 1868 to be identical with the spectrum obtained when an electric spark is passed through olefiant gas, and they are now recognised as due to carbon. The carbon is presumed to be combined with hydrogen, sometimes also with nitrogen; in the case of comets approaching very near the sun, the lines of sodium, and others which have been supposed to be iron-lines, are seen.*

Tait's suggestion.

60. The discovery made by Schiaparelli proves, as already pointed out, that there is a relationship between comets and meteoritic swarms; Schiaparelli himself held the view that a comet and its attendant swarms are merely of identical origin. In 1869 † Tait discussed, from a purely dynamical point of view, the question as to whether the swarm of meteorites attending a comet may not really be part of the comet itself; he shewed that many cometary characters can be mechanically explained on the assumption that comets are really swarms of small meteorites, and pointed out that the self-luminosity may be produced by the heating of the individuals through collision with each other.

Reproduction of the spectrum of a comet.

61. Flutings exactly identical with those seen in the spectrum of a comet were obtained by Professor A. W. Wright in 1875 ‡ on allowing the electric glow to pass through a heated tube, in which, after the introduction of fragments of the Iowa meteorite, the gaseous density had been reduced by an air-pump. The bright lines, too, in the spectrum of a comet, even when nearest to the sun, are found by Sir Norman Lockyer to be identical with those yielded when the electric glow is passed over ordinary meteorites at comparatively low temperatures; and further, the changes in these lines as the comet approaches and recedes from the sun are exactly those which take place on variation of the temperature of the meteorites enclosed in the glow-tubes.

* Presidential Address to the Brit. Assoc. for the Advancement of Science, 1891.

† Proc. Roy. Soc., Edinb., 1869, vol. 6, p. 553.

‡ American Jour. Sc., 1875, ser. 3, vol. 10, p. 44.

A comet is perhaps a swarm of meteorites.

62. From these facts it is inferred that a comet may be in every instance a swarm of isolated meteorites, at a not very high temperature, shining partly by reflected sunlight and partly by the electric glowing of the gases evolved owing to the action of the sun's heat on the meteorites: further, some of the heat may be due to the clashing together of the meteorites, the grouping of which becomes more and more condensed as the swarm approaches the sun.

The gases driven from the meteorites by the sun's heat would be quite sufficient in quantity to form the tail of the comet: as pointed out by Professor Wright, a meteorite like that which fell at Cold Bokkeveld would furnish 30 cubic miles of gas measured at the pressure of our own atmosphere, and in space itself this gas would expand to enormous dimensions owing to the small mass and attraction of the meteoritic swarm. We are still uncertain, however, as regards the actual physical condition of the matter composing the tail of a comet.

Saturn's rings are probably swarms of meteorites.

63. Clerk-Maxwell proved, as long ago as 1857, that the stability of the rings which revolve round the planet Saturn is inconsistent with their being formed of continuous solid or liquid matter; and has shown, by mechanical reasoning, that they must be revolving clouds of small separate bodies, like cannon-shot, each moving as a satellite and almost independent of the rest in its motion: determination of the motions of the inner and outer parts of the ring-system made with the help of the spectroscope supports this conclusion.

Nebulæ.

64. Reichenbach, in 1858, before the self-luminosity had been proved by means of the spectroscope, had imagined a nebula to be a cloud of isolated meteorites, illuminated by some neighbouring sun: Chladni, long before, had supposed a nebula to be a cloud of phosphorescent dust. But, in 1864, it was established by Sir William Huggins that the light is due, not to reflection or phosphorescence, but to incandescence, for the spectrum consists of bright lines such as are yielded by glowing gas. Tait,* in 1871, suggested that the nebulæ may be clouds of mutually impinging meteorites,

* Proc. Roy. Soc., Edinb., 1871, vol. 7, p. 460.

mingled with glowing gases developed by the impacts; he pointed out that the heat produced by the clashing of the individuals of such an immense group as a nebula evidently is would be quite adequate for the production of their light. Sir Norman Lockyer finds that the bright lines (generally accompanied by a certain amount of continuous spectrum) which have been observed in nebular spectra are consistent with this suggestion, and regards them as closely related to the low temperature lines obtained when a gentle electric glow is passed over meteorite-fragments in a tube containing gases given out by them, and of which the density has been reduced by the air-pump; further, he points out that the nebular spectrum is identical with that of the comets of 1866 and 1867 when distant from the sun. According to this suggestion, a nebula and a comet are of identical constitution, and a comet is merely a nebula which has become entangled in the solar system. On the other hand, Sir William Huggins has expressed (1891) the opinion that the spectrum of the bright-line nebulæ is certainly not such as we should expect to result from the collision of meteorites like those which have reached the earth, and that it is suggestive of a high temperature; he points out that the particles which have just been in collision may be at high temperatures and yet the average temperature of all the particles may be low.

Stars. **65.** The examination and classification of the spectra of the stars has likewise led to remarkable conclusions. Secchi, following Rutherfurd, found that the stars could be distributed into classes according to the characters of their spectra,* and his classification has since, with little modification, been adopted by Vogel and Dunér, by whom several thousand star-spectra have now been systematically mapped. The first three classes are characterised by absorption, the fourth by radiation.

In the spectra of Class I the absorption is small and simple, the dark lines being broad and few; the stars themselves are white: in one division of this class, represented by Sirius and Vega, the principal lines are due

* Lockyer. *Nature*, 1886, vols. 33 and 34.

to hydrogen; in another important division, represented by β, γ, δ, ϵ, ζ Orionis, lines of helium are very pronounced.

In Class II the dark lines are thinner and more numerous; the stars are bluish-white to reddish-yellow: to this class belong the Sun, Arcturus, Capella.

The absorption in Class III manifests itself predominantly as flutings, though there are also many thin lines: the stars are orange or red: in one division (*a*) of this class the darkest part and the sharpest edge of each fluting is towards the violet end of the spectrum, as in Betelgeux; in a smaller division (*b*) the darkest part of each fluting is towards the red end, as in star 152 Schjellerup; the fluting absorption of the latter division being due to carbon.

The remaining Class IV is an extremely small one: the spectra are characterised by bright lines: some of the lines are due to hydrogen, and others to substances not yet recognised in terrestrial chemistry.

Supposed cooling of all the stars.

66. Soon after the classification suggested by Secchi had been announced, it was surmised that the differences in the stars of the first three classes might be due, not so much to differences of matter, as to differences of temperature, and that a very hot star such as, from its brightness and distance, its small and simple absorption, and the development of the blue end of its spectrum, Vega is believed to be, would, on getting older and colder, pass from Class I to Class II, and thence to one or other of the divisions of Class III.

New stars.

67. In 1866 a star of 9th or 10th magnitude burst into greater brilliancy and nearly reached the intensity of Vega; the spectrum showed the presence of brilliantly glowing hydrogen. Almost as suddenly the light went down again, and within a month returned to its original brightness. Ten years later, another new star of the 3rd or 4th magnitude appeared at a place in the sky where no star had been noticed before; its spectrum showed numerous bright lines; gradually, in the course of a year, it dwindled down to the 10th magnitude, then giving the telescopic appearance and the spectrum of a nebula. Several other new stars have since been observed, the most notable being

Nova Persei, which appeared in 1901. In each case, as the star faded, its spectrum changed into that which is characteristic of the nebulæ.

The appearance of a new star has been generally attributed to the collision of two bodies in space; Sir Norman Lockyer * has pointed out that the rapidity of the change in the brilliancy, so different from that of other stars, may be due to the smallness of the mass, and that such a star may produced by the collision of two swarms of widely separated meteorites. He has shown that the changes in the spectrum as such a star varies in brightness are confirmatory of this view.

The heat of the sun.

68. That the heat of our own sun was originated by the falling together of smaller bodies was, until lately, generally acknowledged;† for the only other conceivable natural cause, known to exist from independent evidence, namely, chemical combination, was quite insufficient; the greatest amount of heat obtainable from the most advantageous chemical combination of any of the then known elements, having a total mass equal to that of the sun, would not cover the sun's expenditure for more than three thousand years, while there is no difficulty on the meteoritic explanation in providing a supply of heat sufficient to cover the loss by radiation during 20,000,000 years. But the discovery that compounds of radium maintain themselves at a higher temperature than that of surrounding bodies and are only inappreciably changed though continuously emitting an appreciable amount of heat, shows that the meteoritic hypothesis as to the cause of the sun's high temperature is not necessarily the true one: there may be an analogous heat-yielding material in the sun.

In any case the present loss of the sun's heat by radiation is probably not covered by the fall of bodies into the sun; for the requisite mass would, if from distant regions, visibly affect the motions of the planets by its attraction, and, even if circulating round the sun at no great distance

* *Nature*, 1877, vol. 16, p. 413.

† Treatise on Natural Philosophy, by Thomson and Tait: *Cambridge*, 1883, vol. 1, part 2, p. 487.

from it, would seriously disturb the motions of some of the comets. Further, much heat will result from the shrinkage of the volume of the solar aggregate.

Evolution of the heavenly bodies.

69. By study of the spectra, at various temperatures, of the elements and compounds found in those meteorites which have reached our earth and been preserved, Sir Norman Lockyer * has been led to support the view that the stars are not at present all cooling down, but that some, on the contrary, are rising in temperature; he suggests that many of the stars, like the nebulæ, are constituted of separate meteorites in continual relative motion, and become hotter and hotter through contraction of the grouping, collision, and transformation of the energy of position and motion into heat. This increase of temperature must continue during successive ages, until the energy of position and motion of the separate meteorites is wholly transformed, the separate masses having then combined to form a single white hot body which will gradually cool down to the state in which our own moon now is. If a swarm of meteorites forming one nebula be subjected to the external action of another moving swarm of meteorites, intermediate stages resembling the conditions of Saturn and of the solar system may ensue.

According to this spectroscopic affirmation of the nebular theory, all the heavenly bodies are constituted of the same kinds of elementary matter, those in fact which are found in meteorites and our own earth, and the difference is solely due to temperature; and a nebula in its gradual passage to the lunar condition will show every phase of spectrum observed in the stars as now existent.

Meteorites present no evidence of life.

70. Finally, it may be asked whether or not meteorites bring us any tangible evidence of the existence of living beings outside our own world. To this we may briefly answer, that while an organic origin can scarcely be claimed for the graphite present in the meteoric irons, there are no less than six meteoric stones which contain, though in very minute quantity, carbon compounds of such a character

* Proc. Royal Society, 1887, vol. 43, p. 117: 1888, vol. 44, Bakerian lecture.

that their presence in a terrestrial body would be regarded as doubtlessly an indirect result of animal or vegetable existence. On the other hand, the stony matter is such that in a terrestrial body an igneous origin would be assumed.

Professor Maskelyne has pointed out that these carbon compounds can be completely removed without a preliminary pulverisation of the stone, and thus seem to be contained merely in the pores; he suggested that they may have been absorbed by the stones in their passage through an atmosphere containing the compounds in a state of vapour. In any case, it is impossible to prove that there is a necessary relation between these compounds of carbon and the existence of living beings.

Chondrules have been mistaken for organisms.

71. In 1880 * descriptions were given of sponges, corals, crinoids and plants, found in several meteorites, chiefly in that of Knyahinya, but the memoir has been generally regarded as an elaborate jest. The chondrules with their excentrically radiating crystallisation are there classified and named as sponges, corals and crinoids, while the structure of meteoric iron, revealed by the Widmanstätten figures, is regarded as a result of plant life. There can be no hesitation in asserting that as yet no organised matter has been found in meteorites.

* Die Meteorite (Chondrite) und ihre Organismen: von Dr. O. Hahn. Tübingen, 1880.

LIST OF THE METEORITES

REPRESENTED IN THE COLLECTION.

The references in the second column correspond with numbers and letters on the cases, and indicate the pane behind which the meteorite will be found.

Weights under one gram are not given. 1,000 grams are equivalent to 2·205 avdp. lbs.

I. SIDERITES

or Meteoric Irons

(*consisting chiefly of nickeliferous iron, and enclosing schreibersite, troilite, graphite, &c.*).

A. Fall Recorded.

[Arranged chronologically.]

No.	Pane.	Name of Meteorite and Place of Fall.	Date of Fall.	Weight in grams.
1	1*c*	**Agram** (Hraschina), Croatia, Austria.	May 26, 1751.	282
2	1*c*	**Charlotte**, Dickson County, Tennessee, U.S.A.	July 31, or Aug. 1, 1835.	77
3	1*c*,4*l*	**Braunau** (Hauptmannsdorf), Bohemia.	July 14, 1847.	553
4	1*c*,4*l*	**Victoria West**, Cape Colony, South Africa.	Fell in 1862.	158
5	1*c*,4*h*	**Nedagolla**, Miraugi, Vizagapatam, Madras, India.	Jan. 23, 1870.	4,379
6	1*c*	**Rowton**, near Wellington, Shropshire.	April 20, 1876.	3,109
7	1*c*	**Mazapil**, Zacatecas, Mexico.	Nov. 27, 1885.	14
8	1*c*	**Cabin Creek**, Johnson County, Arkansas, U.S.A.	March 27, 1886.	5
9	1*c*	**N'Goureyma**, Djenne, Massina, North-West Africa.	June 15, 1900.	871

B. Fall not Recorded.

[Arranged topographically.]

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
10	1*c*	**La Caille,** near Grasse, Alpes Maritimes, France. For about two centuries it was in front of the church of La Caille and was used as a seat: its meteoric origin was recognised by Brard in 1828.	Acad. Sci. Bordeaux, 1829, p. 39.	375
11	1*c*	**São Julião de Moreira,** Ponte de Lima, Minho, Portugal. Known since 1883: described by Ben-Saude in 1888.	Comm. da commiss. d. trab. geol. de Portugal, 1888, vol. 2, p. 14.	754
12	1*a*	**Obernkirchen,** near Bückeburg, Schaumburg-Lippe, Germany. Found in a quarry on the Bückeberg 15 feet below the surface, and thrown aside: recognised as meteoric by Wicke and Wöhler, in 1863.	Pogg. Ann. 1863, vol. 120, p. 509.	35,366
13	1*d*	**Bitburg,** Rhenish Prussia. Dug up about 1807, taken to Trèves and put into a furnace: afterwards thrown away with the waste: later, fragments of it having been recognised by Gibbs as meteoric, the mass was searched for by Nöggerath and re-discovered in 1824.	Schweigg. Journ. 1825, vol. 43, p. 1.	1,349
14	1*d*, 4*l*	**Seeläsgen,** Brandenburg, Prussia. Found in draining a field: several years afterwards, in 1847, it was met with by Hartig and recognised as meteoric.	Pogg. Ann. 1848, vol. 73, p. 329; 1849, vol. 74, p. 57.	9,846
15	1*d*	**Schwetz,** Prussia. Found in 1850 in making a road; it was about 4 feet below the surface: described by Rose in 1851.	Pogg. Ann. 1851, vol. 83, p. 594.	1,062
16	1*d*	**Nenntmannsdorf,** Pirna, Saxony. Found in 1872 about 2 feet below the surface: reported by Geinitz in 1873.	Sitzungs-Ber. d. n. G. Isis in Dresden, 1873, p. 4.	15
17	1*d*	**Tabarz,** near Gotha, Germany. Said to have been seen by a shepherd to fall on Oct. 18, 1854: described in 1855 by Eberhard, to whom the rust seemed incompatible with a recent fall.	Ann.Chem.Pharm. 1855, vol. 96, p. 286.	9

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
18	1*d*	**Elbogen,** Bohemia. Preserved for centuries at the Rathhaus of Elbogen: its meteoric origin was recognised by Neumann in 1811.	Gilb. Ann. 1812, vol. 42, p. 197.	94
19	1*d*	**Bohumilitz,** Prachin, Bohemia. Laid bare by heavy rain in 1829.	Verh. Ges. Mus. Böhm. April 3, 1830, p. 15.	118
20	1*d*	**Lénárto,** Sáros, Hungary. Found in 1814: described by Tehel in 1815.	Gilb. Ann. 1815, vol. 49, p. 181.	2,028
21	1*d*	**Arva** (Szlanicza), Hungary. Made known by Haidinger in 1844.	Pogg. Ann. 1844, vol. 61, p. 675.	9,010
22	1*d*	**Nagy-Vázsony,** Veszprim, Hungary. Found in 1890: described by Brezina in 1896.	Ann. d.k.k.Naturh. Hofmus. Wien, 1896, vol. 10, pp. 284, 356.	69
23	1*d*	**Tula** (Netschaëvo), Russia. Found in 1846 in making a road: it was 2 feet below the surface: recognised as meteoric by Auerbach in 1857.	Wien. Akad. Ber., 1860 (1861), vol. 42, p. 507.	1,076
24	1*d*	**Sarepta,** Saratov, Russia. Found in 1854: reported by Auerbach in the same year.	Bull. Soc. Nat. Moscow, 1854, p. 504.	296
25	1*d*	**Verkhne-Dnieprovsk,** Ekaterinoslav, Russia. Found in 1876.		24
26	1*d*	**Augustinovka,** Ekaterinoslav, Russia. Known before 1893; fragment described by Meunier in that year.	Comptes Rendus, 1893, vol. 116, p. 1151.	950
27	1*d*	**Bischtübe,** Nikolaev, Turgai, Russia. Found in 1888: described by Kislakovsky in 1890.	Bull. de la Soc. Imp. des Natur. de Moscou, 1890, vol. 4, p. 187.	1750
28	1*d*	**Petropavlovsk** (gold washings), Mrasa River, Tomsk, Asiatic Russia. Found about 32 feet from the surface: given to the Director of the Kolyvani Works in 1841 and described by Sokolovskji in the same year.	Erman's Archiv f. wiss. Kunde von Russland, 1841, vol. 1, p. 314.	12

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
29	1*d*	**Toubil river** (Taiga), Petropavlovsk, Jenisseisk, Asiatic Russia. Found in 1891: described by Khlaponin in 1898.	Verhandl. russ.-kais. min. Ges., 1898, ser. 2, vol. 35, p. 233.	490
30	1*d*	**Ssyromolotovo,** Keshma, Jenisseisk, Asiatic Russia. Known since the year 1873: described by Göbel in 1874.	Bull. Ac. Imp. des Sc. de St. Pétersb. 1874, vol. 19, p. 544.	3
31	1*e*	**Verkhne-Udinsk** (Niro river), Transbaikal, Asiatic Russia. Found in 1854: noted by Buchner in 1865.	Pogg. Ann. 1865, vol. 124, p. 599.	2,904
32	1*e*	**Nochtuisk,** Jakutsk, Asiatic Russia. Found in 1876.		4
33	1*b*	**Nejed** (Wanee Banee Khaled), Central Arabia. Said to have been seen to fall in 1863; probably this is a mistake and the time of fall unknown: described by L. F. in 1887.	Mineralog. Magazine, 1887, vol. 7, p. 179.	59,420
34	1*e*	**Kodaikanal,** Madras, India. Known since 1898: reported by Holland in 1900.	Proc. Asiatic Soc. of Bengal, 1900, January, p. 2.	2,355
35	1*e*	**Mukerop,** Gibeon, Great Namaqualand, South Africa. Found in 1899: described by Brezina and Cohen in 1902.	Jahreshefte des Vereins für Vaterl. Naturk. Württ., 1902, vol. 58, p. 292.	4,320
36	1*e*	**Bethany,** Great Namaqualand, South Africa. Many large masses were reported by Alexander in 1838 to be lying N.E. of Bethany and near the Great Fish River. {None of the fragments given to Alexander seem to have been placed in Museum Collections.} L. F.	Jour. Roy. Geog. Soc. of London, 1838, vol. 8, p. 24.	
		A large mass said to have been found near Lion River, Great Namaqualand, was described by Shepard in 1853.	Amer. Jour. Sc. 1853, ser. 2, vol. 15, p. 1.	388
		A large mass which had long been known to the missionaries of Bethany was brought to Cape Town by Wild in 1860: described by Cohen in 1900. {These two masses, and a fragment (9 grams) said to have been labelled "Springbok River," were probably from the place indicated by Alexander; the etched figures are similar.} L. F.	Annals of the South African Mus. 1900, vol. 2, part 2, p. 21.	1,434

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
37	1*e*	**Orange River** District, South Africa. Sent from the Orange River District in 1855: described by Shepard in 1856.	Amer. Jour. Sc. 1856, ser. 2, vol. 21, p. 213.	95
38	1*e*	**Hex River Mountains,** Cape Colony, South Africa. Found in 1882: described by Brezina in 1896.	Ann. d.k.k. Naturh. Hofmus. Wien, 1896, vol. 10, pp. 291, 349.	245
39	1*e*	**Cape of Good Hope:** between Sunday River and Bushman River (west of Great Fish River), Cape Colony, South Africa. Known long before 1793: mentioned in "Barrow's Travels into the Interior of South Africa," 1801, vol. i. p. 226: full particulars were given in 1805 by von Dankelmann.	Mag. für den neuesten Zustand der Naturkunde, von J. H. Voigt, 1805, vol. 10, p. 12.	340
40	1*e*	**Kokstad,** Griqualand East, South Africa. Known in 1878: described by Cohen in 1900.	Ann. South African Mus. 1900, vol. 2, p. 9.	243
41	1*e*	**Prambanan,** Surakarta, Java. Known as early as 1797, and probably earlier: described by Baumhauer in 1866.	Arch. Néer. Haarlem, 1866, vol. 1, p. 465.	8
42	1*f*	**Thunda,** Windorah, Diamantina District, Queensland, Australia. Described by Liversidge in 1886.	Jour. and Proc. Roy. Soc. of New South Wales, 1887, vol. 20, p. 73.	396
43	1*f*	**Mungindi,** New South Wales, Australia. Found on the Queensland side of the border in 1897: mentioned by Card in 1897 and figured by Ward in 1898.	Rec. Geol. Surv. of New South Wales, 1897, vol. 5, p. 121. Amer. Jour. Sc. 1898, ser. 4, vol. 5, p. 138.	368
44	1*f*	**Cowra,** Bathurst, New South Wales. Known since 1888: described by Card in 1897.	Records of the Geol. Survey of N. S. Wales, 1897, vol. 5, p. 51.	192
45	1*f*	**Nocoleche,** Wanaaring, New South Wales. Known in 1895: described by Cooksey in 1897.	Records of the Australian Mus. 1897, vol. 3, p. 51.	687

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
46	1*f*	**Rhine Villa,** Rhine Valley, South Australia. Described by Goyder in 1901.	Trans. of the Roy. Soc. of South Australia, 1901, vol. 25, p. 14.	193
47	Sep. Stand, 1*f*	**Cranbourne,** near Melbourne, Victoria, Australia. Two large masses, found nearly four miles apart, have been known since 1854: described by Haidinger in 1861. A much smaller mass was found later at Beaconsfield, six miles from Cranbourne: described by Cohen in 1897.	Wien. Akad. Ber. 1861, vol. 43, Abth. 2, p. 583. Sitzungsber. k. pr. Ak. d. Wiss. zu Berlin, 1897, vol. 46, p. 1035.	3,731,000
	1*f*	{Fragments found in Abel's collection of minerals with the label "Yarra Yarra River—Date 1858" had probably been detached from one of the two masses of Cranbourne.} L. F.		214
48	1*e*	**Youndegin,** 70 miles E. of York, Western Australia. Found in 1884: described by L. F. in 1887.	Mineralog. Magazine, 1887, vol. 7, p. 121.	13,157
49	1*f*	**Roebourne** (200 miles south-east of), Western Australia. Found in 1892: described by Cooksey in 1897 and by Ward in 1898.	Records of the Australian Mus. 1897, vol. 3, p. 59. Amer. Jour. Sc. 1898, ser. 4, vol. 5, p. 135.	1,500
50	1*f*	**Mount Stirling,** Western Australia. Known in 1892: described by Cooksey in 1897.	Records of the Australian Mus. 1897, vol. 3, p. 58.	1,888
51	1*f*	**Ballinoo,** Murchison River, Western Australia. Found in 1892: described by Cooksey in 1897 and by Ward in 1898.	Records of the Australian Mus. 1897, vol. 3, p. 55. Amer. Jour. Sc. 1898, ser. 4, vol. 5, p. 136.	3,160
52	1*f*	**Mooranoppin,** Western Australia. Found in or before 1893: described by Cooksey in 1897 and by Ward in 1898.	Records of the Australian Mus. 1897, vol. 3, p. 58. Amer. Jour. Sc. 1898, ser. 4, vol. 5, p. 140.	261

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
53	4*m*	**Melville Bay,** 35 miles east of Cape York, West Greenland (Ross's iron). Two knives or lance-heads with bone handles given to Captain John Ross in 1818 by the Esquimaux of Prince Regent's Bay: one of them was figured by Ross on page 102 of his work. According to the Esquimaux, the iron had been obtained from a neighbouring mountain called Sowallick. The locality of the iron (three large masses) was shown by an Esquimaux to Lieut. Peary in 1894: by him they were transported to New York.	Voyage of Discovery, &c., by Captain John Ross. London, 1819. Northward over the Great Ice, by R. E. Peary. London, 1898, vol. 2, p. 556.	
54	1*f*	**Madoc,** Hastings County, Ontario, Canada. Found in 1854: described by Hunt in 1855.	Amer. Jour. Sc. 1855, ser. 2, vol. 19, p. 417.	216
55	1*f*	**Welland,** Ontario, Canada. Ploughed up in 1888: described by Howell in 1890.	Proc. Rochester Ac. of Sc. 1890, vol. 1, p. 86.	466
56	1*f*	**Thurlow,** Hastings County, Ontario, Canada. Found in 1888: described by Hoffmann in 1897.	Amer. Jour. Sc. 1897, ser. 4, vol. 4, p. 325.	189
57	1*f*	**Iron Creek,** Battle River, North Saskatchewan, Canada. Removed about 1869: described by Coleman in 1886.	Proc. and Trans. Roy. Soc. of Canada, 1887, vol. 4, sec. 3, p. 97.	79
58	1*h*	**Lockport** (Cambria), Niagara County, New York, U.S.A. Turned up by plough: described as meteoric by Silliman in 1845.	Amer. Jour. Sc. 1845, ser. 1, vol. 48, p. 388.	5,329
59	4*l*	**Seneca River,** Cayuga County, New York, U.S.A. Found in 1851, in digging a ditch: described by Root in 1852.	Amer. Jour. Sc. 1852, ser. 2, vol. 14, p. 439.	54
60	1*g*,4*l*	**Burlington,** Otsego County, New York, U.S.A. Turned up by plough some time previous to 1819, and described by Silliman in 1844.	Amer. Jour. Sc. 1844, ser. 1, vol. 46, p. 401.	290

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
61	1*g*	**Pittsburg** (Miller's Run), Alleghany County, Pennsylvania, U.S.A. Described by Silliman in 1850: date of find unknown.	Proc. Amer. Assoc. Fourth Meeting, held Aug. 1850, vol. 4, p. 37.	208
62	1*g*	**Mount Joy,** Adams County, Pennsylvania, U.S.A. Found in 1887: described by Howell in 1892.	Amer. Jour. Sc. 1892, ser. 3, vol. 44, p. 415.	730
63	1*g*	**Emmittsburg,** Frederick County, Maryland, U.S.A. Found in 1854.		6
64	1*g*	**Staunton,** Augusta County, Virginia, U.S.A. Five masses have been found. Three masses, of which two at least were found in 1869, were described by Mallet in 1871. A fourth was found about 1858–9, thrown away, used in the construction of a stone fence, then as an anvil; was next built into a wall: in 1877 it was taken out, and its meteoric nature was recognised by Mallet. A fifth was described by Kunz in 1887.	Amer. Jour. Sc. 1871, ser. 3, vol. 2, p. 10. Amer. Jour. Sc. 1878, ser. 3, vol. 15, p. 337. Amer. Jour. Sc. 1887, ser. 3, vol. 33, p. 58.	2,796
65	1*g*	**Indian Valley Township,** Floyd County, Virginia, U.S.A. Found in 1887: described by Kunz and Weinschenk in 1891.	Tschermak's Min. u. Petrog. Mitth. 1891, vol. 12, p. 182.	82
66	1*g*	**Greenbrier County** (near the summit of the Alleghany Mountain, 3 miles north of White Sulphur Springs), West Virginia, U.S.A. Found about 1880: described by L. F. in 1887.	Mineralog. Magazine, 1887, vol. 7, p. 183.	2,236
67	1*g*	**Jenny's Creek,** Wayne County, West Virginia, U.S.A. The first piece was found before the Spring of 1883 and lost sight of; two other pieces were found in 1883 and 1885 respectively: reported by Kunz in 1885.	Proc. Amer. Assoc. for the year 1885, vol. 34, p. 246.	78

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
68	1*h*	**Smith's Mountain,** Rockingham County, N. Carolina, U.S.A. Reported by Genth in 1875 to have been found in 1866. Reported by Smith in 1877 to have passed into the hands of Kerr about 1863. No mention of date of find by Genth when describing the meteorite in 1885.	Rep. Geol. Surv. N. Carolina, by Kerr: *Raleigh,* 1875, vol. 1, app. C, p. 56. Amer. Jour. Sc. 1877, ser. 3, vol. 13, p. 213. Minerals and Mineral Localities of North Carolina, by Genth and Kerr: *Raleigh,* 1885, p. 15.	77
69	1*h*	**Deep Springs** (farm), Rockingham County, N. Carolina, U.S.A. Known since about 1846: described by Venable in 1890.	Amer. Jour. Sc. 1890, ser. 3, vol. 40, p. 161.	170
70	1*h*	**Guilford County,** N. Carolina, U.S.A. Date of find unknown: first described by Shepard as terrestrial in 1830, but in 1841 its meteoric origin was recognised by him.	Amer. Jour. Sc. 1830, ser. 1, vol. 17, p. 140; and 1841, vol. 40, p. 369.	15
71	1*h*	**Lick Creek,** Davidson County, North Carolina, U.S.A. Found in 1879: described by Hidden in 1880.	Amer. Jour. Sc. 1880, ser. 3, vol. 20, p. 324.	20
72	1*h*	**Linnville Mountain,** Burke County, N. Carolina, U.S.A. Found about 1882: described by Kunz in 1888.	Amer. Jour. Sc. 1888, ser. 3, vol. 36, p. 275.	21
73	1*h*	**Ellenboro',** Rutherford County, N. Carolina, U.S.A. Found in 1880: described by Eakins in 1890.	Amer. Jour. Sc. 1890, ser. 3, vol. 39, p. 395.	53
74	1*h*	**Bridgewater,** Burke County, N. Carolina, U.S.A. Found by a ploughman: described by Kunz in 1890.	Amer. Jour. Sc. 1890, ser. 3, vol. 40, p. 320.	51
75*a*	1*h*,4*l*	**Jewell Hill,** Walnut Mtns., Madison County, N. Carolina, U.S.A. One was given to Smith in 1854, and described by him in 1860.	Amer. Jour. Sc. 1860, ser. 2, vol. 30, p. 240; and Orig. Res. in Min. and Chem. by Lawrence Smith, 1884, p. 409.	130

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
75*b*	1*h*	A second was found in use in 1873, supporting a corner of a rail-fence: described as from Duel Hill by Burton in 1876. The etched figures are different for the two masses.	Amer. Jour. Sc. 1876, ser. 3, vol. 12, p. 439. The Minerals and Mineral Localities of North Carolina, by Genth and Kerr: *Raleigh*, 1885, p. 14.	12
76	1*h*	**Black Mountain,** 15 m. E. of Asheville, Buncombe County, N. Carolina, U.S.A. Found about 1839, and described by Shepard in 1847.	Amer. Jour. Sc. 1847, ser. 2, vol. 4, p. 82.	71
77	1*h*	**Asheville** (Baird's Plantation, 6 m. N. of), Buncombe County, N. Carolina, U.S.A. Found loose in the soil: described by Shepard in 1839.	Amer. Jour. Sc. 1839, ser. 1, vol. 36, p. 81; and 1847, ser. 2, vol. 4, p. 79.	111
78	1*h*	**Murphy,** Cherokee County, N. Carolina, U.S.A. Found in 1899: described in the same year by Ward.	Amer. Jour. Sc. 1899, ser. 4, vol. 8, p. 225.	1,539
79	1*k*	**Chesterville,** Chester County, S. Carolina, U.S.A. Ploughed up several years before 1849, when it was described by Shepard.	Amer. Jour. Sc. 1849, ser. 2, vol. 7, p. 449.	2,250
80	1*k*	**Laurens County,** S. Carolina, U.S.A. Found in 1857: described by Hidden in 1886.	Amer. Jour. Sc. 1886, ser. 3, vol. 31, p. 463.	63
81	1*k*	**Ruff's Mountain,** Lexington County, S. Carolina, U.S.A. Date of find not stated: described by Shepard in 1850.	Amer. Jour. Sc. 1850, ser. 2, vol. 10, p. 128.	498
82	1*k*	**Lexington County,** S. Carolina, U.S.A. Found in 1880: described by Shepard in 1881.	Amer. Jour. Sc. 1881, ser. 3, vol. 21, p. 117.	271
83	1*k*	**Union County,** Georgia, U.S.A. Found in 1853: described by Shepard in 1854.	Amer. Jour. Sc. 1854, ser. 2, vol. 17, p. 328.	55

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
84	1*k*	**Whitfield County** (Dalton), Georgia, U.S.A. First specimen found in 1877: particulars of find, and description, given by Hidden in 1881. A second specimen was found in 1879, and described by Shepard in 1883.	Amer. Jour. Sc. 1881, ser. 3, vol. 21, p. 286. Amer. Jour. Sc. 1883, ser. 3, vol. 26, p. 337.	146
85	1*l*	**Losttown** (2½ m. S.W. of), Cherokee County, Georgia, U.S.A. Ploughed up in 1868: described in the same year by Shepard.	Amer. Jour. Sc. 1868, ser. 2, vol. 46, p. 257.	6
86	1*l*	**Canton,** Cherokee County, Georgia, U.S.A. Ploughed up in 1894: described by Howell in 1895. According to Brezina, Canton and Losttown probably belong to the same fall.	Amer. Jour. Sc. 1895, ser. 3, vol. 50, p. 252.	335
87	1*l*	**Holland's Store,** Chattooga County, Georgia, U.S.A. Found in 1887: described by Kunz in the same year.	Amer. Jour. Sc. 1887, ser. 3, vol. 34, p. 471.	204
88	1*l*	**Forsyth County,** Georgia (not N. Carolina), U.S.A. Found about 1892: described by Schweinitz in 1896 and Cohen in 1897; the former gives the State as "N. Carolina."	Amer. Jour. Sc. 1896, ser. 4, vol. 1, p. 208. Sitzungsber. k. pr. Ak. d. Wiss. zu Berlin, 1897, p. 386.	324
89	1*l*	**Locust Grove,** Henry County, Georgia, (? N. Carolina), U.S.A. Found in 1857: described by Cohen in 1897, who gives the State as "N. Carolina."	Sitzungsber. k. pr. Ak. d. Wiss. zu Berlin, 1897, p. 76.	365
90	1*l*	**Putnam County,** Georgia, U.S.A. Found in 1839: described by Willet in 1854.	Amer. Jour. Sc. 1854, ser. 2, vol. 17, p. 331.	112
91	1*l*	**Chulafinnee,** Cleberne County, Alabama, U.S.A. Ploughed up in 1873: described by Hidden in 1880.	Amer. Jour. Sc. 1880, ser. 3, vol. 19, p. 370.	60
92	1*l*	**Auburn,** Lee (not Macon) County, Alabama, U.S.A. Ploughed up some years before 1869, when it was described by Shepard.	Amer. Jour. Sc. 1869, ser. 2, vol. 47, p. 230.	37

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
93	1*l*	**Summit,** Blount County, Alabama, U.S.A. Known since 1890: described by Kunz in the same year.	Amer. Jour. Sc. 1890, ser. 3, vol. 40, p. 322.	47
94	1*h*	**Walker County,** Alabama, U.S.A. Found in 1832: described by Troost in 1845.	Amer. Jour. Sc. 1845, ser. 1, vol. 49, p. 344.	22,335
95	1*l*	**Claiborne** (Lime Creek), Clarke County, Alabama, U.S.A. Mentioned in 1834: described by Jackson in 1838.	Amer. Jour. Sc. 1838, ser. 1, vol. 34, p. 332.	19
96	1*l*	**Tombigbee River,** Choctaw and Sumter Counties, Alabama, U.S.A. Various masses found about 1859 and afterwards: described by Foote in 1899.	Amer. Jour. Sc. 1899, ser. 4, vol. 8, p. 153.	7,890
97	1*l*	**Oktibbeha County,** Mississippi, U.S.A. Found in an Indian tumulus: described by Taylor in 1857.	Amer. Jour. Sc. 1897, ser. 2, vol. 24, p. 293.	—
98	1*l*	**Cocke County** (Cosby's Creek), Tennessee, U.S.A. Described in 1840 by Troost: date of find unknown.	Amer. Jour. Sc. 1840, ser. 1, vol. 38, p. 253.	52,325
99	1*l*	**Babb's Mill,** Green County, Tennessee, U.S.A. Turned up by a plough: first mentioned in 1842: described by Troost in 1845.	Amer. Jour. Sc. 1845, ser. 1, vol. 49, p. 342.	2,164
100	1*l*	**Tazewell,** Claiborne County, Tennessee, U.S.A. Turned up by a plough in 1853: described by Shepard in 1854.	Amer. Jour. Sc. 1854, ser. 2, vol. 17, p. 325.	336
101	1*l*	**Waldron Ridge,** Claiborne County, Tennessee, U.S.A. Known since 1887: described by Kunz in the same year.	Amer. Jour. Sc. 1887, ser. 3, vol. 34, p. 475.	70
102	1*l*	**Cleveland,** Bradley County, Tennessee, U.S.A. This mass was acquired in 1867 by Lea, and described by Genth in 1886.	Proc. Ac. Nat. Sc. Philad. 1886, p. 366.	209

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
103	1*l*	**Jackson County,** Tennessee, U.S.A. Date of find unknown: described in 1846 by Troost.	Amer. Jour. Sc. 1846, ser. 2, vol. 2, p. 357.	91
104	1*m*	**Carthage,** Smith County, Tennessee, U.S.A. Found about 1844: described in 1846 by Troost.	Amer. Jour. Sc. 1846, ser. 2, vol. 2, p. 356.	24,570
105	1*l*	**Caney Fork,** De Kalb County, Tennessee, U.S.A. Turned up by a plough, near the mouth of the Caney Fork ("Caryfort"), date not mentioned: described by Troost in 1845.	Amer. Jour. Sc. 1845, ser. 1, vol. 49, p. 341.	4
106	1*l*	**Smithville,** De Kalb County, Tennessee, U.S.A. Three masses were ploughed up in 1892-3: described by Huntington in 1894.	Proc. Amer. Ac. Arts & Sci. 1894: new series, vol. 21, p. 251.	1,745
107	1*l*	**Murfreesboro',** Rutherford County, Tennessee, U.S.A. Found about 1847–8: described in 1848 by Troost.	Amer. Jour. Sc. 1848, ser. 2, vol. 5, p. 351.	2,794
108	1*l*	**Coopertown,** Robertson County, Tennessee, U.S.A. Sent to Smith in 1860: described by him in 1861.	Amer. Jour. Sc. 1861, ser. 2, vol. 31, p. 266.	180
109	1*m*	**Kenton County** (8 miles south of Independence), Kentucky, U.S.A. Found in 1889: described by Preston in 1892.	Amer. Jour. Sc. 1892, ser. 3, vol. 44, p. 163.	2,520
110	1*m*, 4*l*	**Lagrange,** Oldham County, Kentucky, U.S.A. Found in 1860: described by Smith in 1861.	Amer. Jour. Sc. 1861, ser. 2, vol. 31, p. 265.	217
111	1*m*	**Frankfort** (8 miles S.W. of), Franklin County, Kentucky, U.S.A. Found in 1866: described (1870) by Smith.	Amer. Jour. Sc. 1870, ser. 2, vol. 49, p. 331.	98
112	1*m*, 4*l*	**Salt River,** about 20 miles below Louisville, Kentucky, U.S.A. Date of find not mentioned: described by Silliman in 1850.	Proc. Amer. Assoc. Fourth Meeting, held Aug. 1850, vol. 4, p. 36.	524

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
113	1m, 4l	**Nelson County,** Kentucky, U.S.A. Turned up by a plough in 1860: described by Smith in the same year.	Amer. Jour. Sc. 1860, ser. 2, vol. 30, p. 240.	3,907
114	1m	**Casey County,** Kentucky, U.S.A. Mentioned in 1877 by Smith.	Amer. Jour. Sc. 1877, ser. 3, vol. 14, p. 246.	45
115	1m	**Scottsville,** Allen County, Kentucky, U.S.A. Found in 1867: described by Whitfield in 1887.	Amer. Jour. Sc. 1887, ser. 3, vol. 33, p. 500.	409
116	1m	**Smithland,** Livingston County, Kentucky, U.S.A. Found about 1839–40, and described in 1846 by Troost.	Amer. Jour. Sc. 1846, ser. 2, vol. 2, p. 357.	2,556
117	1m	**Marshall County,** Kentucky, U.S.A. Described by Smith in 1860.	Amer. Jour. Sc. 1860, ser. 2, vol. 30, p. 240.	80
118	1m	**Wayne County** (near Wooster), Ohio, U.S.A. Found about 1858: described by Smith in 1864.	Amer. Jour. Sc. 1864, ser. 2, vol. 38, p. 385.	5
119	1m	**Grand Rapids,** Kent County, Michigan, U.S.A. Found in 1883 about 3 feet below the surface: reported by Eastman in 1884.	Amer. Jour. Sc. 1884, ser. 3, vol. 28, p. 299.	1,146
120	1m	**Reed City,** Osceola County, Michigan, U.S.A. Found in 1895: described by Preston in 1903.	Proc. Rochester Ac. of Sc., 1903, vol. 4, p. 89.	876
121	1m	**Howard County** (7 miles S.E. of Kokomo), Indiana, U.S.A. Found in 1862 or 1870 at a depth of 2 feet: described by Cox in 1872 and by Smith in 1874.	Amer. Jour. Sc. 1873, ser. 3, vol. 5, p. 155; and 1874, ser. 3, vol. 7, p. 391.	38
122	1m	**Plymouth,** Marshall County, Indiana, U.S.A. Found in 1893 by a ploughman: described by Ward in 1895.	Amer. Jour. Sc. 1895, ser. 3, vol. 49, p. 53.	446
123	1m	**Independence County** (about 7 miles east of Batesville), Arkansas, U.S.A. Found in 1884: described by Hidden in 1886.	School of Mines Quarterly, 1886, vol. 7, No. 2, Jan., p. 188.	372

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
124	1*n*	**South-East Missouri,** U.S.A. Found in 1863 in the Museum of St. Louis, labelled "South-East Missouri": reported by Shepard in 1869.	Amer. Jour. Sc. 1869, ser. 2, vol. 47, p. 233.	102
125	1*p*	**St. Genevieve County,** Missouri, U.S.A. Found in 1888.		6,435
126	1*n*	**Central Missouri,** U.S.A. Found about 1850–60: described by Preston in 1900.	Amer. Jour. Sc. 1900, ser. 4, vol. 9, p. 285.	988
127	1*n*	**Butler,** Bates County, Missouri, U.S.A. Turned up by a plough: long afterwards came to the knowledge of Broadhead, who mentioned it in 1875.	Amer. Jour. Sc. 1875, ser. 3, vol. 10, p. 401.	389
128	1*n*	**Arlington,** Sibley County, Minnesota, U.S.A. Found in 1894: described by Winchell in 1896.	Amer. Geologist, 1896, vol. 18, p. 267.	56
129	1*n*	**Trenton,** Washington County, Wisconsin, U.S.A. Turned up by a plough in 1858: described by Dörflinger in 1868.	Smithson. Rep. for 1869: p. 417.	223
130	1*n*	**Hammond Township,** St. Croix County, Wisconsin, U.S.A. Ploughed up in 1884: described by Fisher in 1887.	Amer. Jour. Sc. 1887, ser. 3, vol. 34, p. 381.	62
131	1*n*	**Algoma,** Kewaunee County, Wisconsin, U.S.A. Found in 1887: described by Hobbs in 1902 (1903).	Bull. Geol. Soc. America, 1903, vol. 14, p. 97.	17
132	1*n*	**Dakota,** U.S.A. Described in 1863 by Jackson.	Amer. Jour. Sc. 1863, ser. 2, vol. 36, p. 259.	223
133	1*n*	**Jamestown** (15 or 20 miles south-east of), Stutsman County, N. Dakota, U.S.A. Found in 1885: described by Huntington in 1890.	Proc. Amer. Ac. Arts & Sci. 1890, vol. 25 (new ser., vol. 17), p. 229.	1,627
134	1*n*	**Niagara,** Grand Forks County, N. Dakota, U.S.A. Found in 1879: described by Preston in 1902.	Jour. of Geology, 1902, vol. 10, p. 518.	17

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
135	1*n*	**Nebraska** (25 m. N.W. of Fort Pierre), Dakota, U.S.A. Brought away in 1857: described by Holmes in 1860.	Trans. of St. Louis Acad. of Sc. 1857–60, vol. 1, p. 711.	2,016
136	1*n*	**Crow Creek,** Laramie County, Wyoming, U.S.A. Found in 1887: described by Kunz in 1888.	Amer. Jour. Sc. 1888, ser. 3, vol. 36, p. 276.	583
137	1*n*	**Illinois Gulch,** Deer Lodge County, Montana, U.S.A. Found in 1899: described by Preston in 1900.	Amer. Jour. Sc. 1900, ser. 4, vol. 9, p. 201.	637
138	1*n*	**Tonganoxie,** Leavenworth County, Kansas, U.S.A. Found in 1886: described by Bailey in 1891.	Amer. Jour. Sc. 1891, ser. 3, vol. 42, p. 385.	260
139	1*n*	**Russel Gulch,** Gilpin County, Colorado, U.S.A. Found in 1863: described in 1866 by Smith.	Amer. Jour. Sc. 1866, ser. 2, vol. 42, p. 218.	245
140	1*n*	**Bear Creek,** Denver, Colorado, U.S.A. Found in 1866: described by Shepard in the same year.	Amer. Jour. Sc. 1866, ser. 2, vol. 42, pp. 250, 286.	52
141	1*n*	**Franceville,** Colorado, U.S.A. Found in 1890.		770
142	1*n*	**Hayden Creek,** Lemhi County, Idaho, U.S.A. Known in 1895: described by Hidden in 1900.	Amer. Jour. Sc. 1900, ser. 4, vol. 9, p. 367.	79
143	1*o*	**Oroville,** Butte County, California, U.S.A. Found in 1893.		372
144	1*o*	**Shingle Springs,** El Dorado County, California, U.S.A. Found 1869–70: described by Silliman in 1873.	Amer. Jour. Sc. 1873, ser. 3, vol. 6, p. 18.	84
145	1*o*	**Ivanpah,** San Bernardino County, California, U.S.A. Described by Shepard in 1880, shortly after its discovery.	Amer. Jour. Sc. 1880, ser. 3, vol. 19, p. 381.	33

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
146	1*o*	**Surprise Springs,** Bagdad, San Bernardino County, S. California, U.S.A. Found in 1899: described by Cohen in 1901.	Mittheil. naturw. Verein für Neu-Vorpommern und Rügen, 1902, Jahrg. 33, p. 29.	97
147	Sep. Stand, 1*o*	**Cañon Diablo,** Arizona, U.S.A. Found in 1891: described by Foote in the same year.	Amer. Jour. Sc. 1891, ser. 3, vol. 42, p. 413.	83,715
148	1*n*	**Tucson,** Arizona, U.S.A. Two large masses, long preserved at Tucson, had been transported to that town from the Puerto de los Muchachos, a pass about 20 or 30 miles south of Tucson. Their existence has been known for centuries. One of them has been termed the Signet or Irwin-Ainsa iron, the other the Carleton iron.	Mineralog. Magazine, 1890, vol. 9, p. 16.	161 282
149	1*o*	**Costilla Peak,** Cimarron Range, New Mexico, U.S.A. Found in 1881 by a sheep-herder: described by Hills in 1895.	Proc. Colorado Scient. Soc. 1895, vol. 5, p. 121.	1,595
150	1*o*	**Capitan Range,** New Mexico, U.S.A. Found in 1893 by a sheep-herder: described by Howell in 1895.	Amer. Jour. Sc. 1895, ser. 3, vol. 50, p. 253.	956
151*a*	1*o*	**Glorieta Mountain,** 1 m. N.E. of Canoncito, Santa Fé County, New Mexico, U.S.A. Found in 1884: described by Kunz in 1885.	Amer. Jour. Sc. 1885, ser. 3, vol. 30, p. 235.	1,527
151*b*	1*o*	A specimen probably from this locality was sent in 1884 to Denver from Albuquerque, New Mexico, as silver bullion: described by Pearce and Eakins in 1884–5.	Proc. Colorado Scient. Soc. 1884, vol. 1, p. 110; 1885, vol. 2, pp. 14, 35.	61
152	1*o*	**Sacramento Mountains,** Eddy County, New Mexico, U.S.A. Known in 1896: described by Foote in 1896 (1897).	Amer. Jour. Sc. 1897, ser. 4, vol. 3, p. 65.	14,050
153	1*o*	**Luis Lopez,** Socorro County, New Mexico, U.S.A. Found in 1896: described by Preston in 1900.	Amer. Jour. Sc. 1900, ser. 4, vol. 9, p. 283.	426

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
154	1*o*	**Oscuro Mountain,** Socorro County, New Mexico, U.S.A. Found in 1895: described by Hills in 1897.	Proc. Colorado Scient. Soc. 1897, vol. 6, p. 30.	494
155	1*o*	**Brazos River,** Wichita County, Texas, U.S.A. Known to the Comanches for many years: removed in 1836: described by Shumard in 1860, and by Mallet in 1884.	Trans. of St. Louis Acad. of Sc. 1857–60, vol. 1, p. 622. Amer. Jour. Sc. 1884, ser. 3, vol. 28, p. 285.	1,395
156	1*o*	**Denton County,** Texas, U.S.A. After discovery it remained with a blacksmith for several months; in 1859 it came into the possession of Shumard, by whom it was described in the following year.	Trans. of St. Louis Acad. of Sc. 1857–60, vol. 1, p. 623.	122
157	1*o*	**Red River** (Cross Timbers), Johnson County, Texas, U.S.A. Mentioned in 1808 to Captain Glass, and reported by Gibbs in 1814.	Amer. Min. Jour. by Bruce: 1814, vol. 1, pp. 124, 218. Amer. Jour. Sc. 1824, ser. 1, vol. 8, p. 218.	424
158	1*n*	**Carlton,** Hamilton County, Texas, U.S.A. Ploughed up in 1887–8: described by Howell in 1890.	Proc. Rochester Ac. of Sc., 1890, vol. 1, p. 87. Amer. Jour. Sc. 1890, ser. 3, vol. 40, p. 223.	6,185
159	1*o*	**Kendall County,** Texas, U.S.A. Found before 1887.	Verhand. d. Ges. deut. Naturf. u. Arzte: Theil II., Hälfte I.: p. 166. (Naturw. Abtheil.) 1894.	556
160	1*o*	**Mart,** McLennan County, Texas, U.S.A. Found in 1898: described by Merrill and Stokes in 1899 (1900).	Proc. Washington Acad. Sci. 1900, vol. 2, p. 51.	431
161	1*o*	**San Angelo,** Tom Green County, Texas, U.S.A. Found in 1897: described by Preston in 1898.	Amer. Jour. Sc. 1898, ser. 4, vol. 5, p. 269.	770
162	1*o*	**Fort Duncan,** Maverick County, Texas, U.S.A. Found in 1882: described by Hidden in 1886: similar to Coahuila; perhaps transported from the same district by way of Santa Rosa.	Mineralog. Magazine, 1890, vol. 9, p. 116.	4,520

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
163*a*	2*c*	**Coahuila,** Mexico. Since 1837 many masses have been brought to Santa Rosa, from a district of small area about 90 miles north-west of that town. An account of a visit by Hamilton was published by Shepard in 1866; he designated the iron by the name Bonanza: eight large masses were removed to the United States by Butcher in 1868.	Mineralog. Magazine, 1890, vol. 9, p. 107.	253,645
163*b*	2*c*	**Sanchez Estate,** Coahuila, Mexico. Found in 1853 by Couch in use as an anvil at Saltillo. It was said to have been brought to that town from the "Sancha Estate," but had probably been acquired still earlier at Santa Rosa, and been got at the north-west locality.	Mineralog. Magazine, 1890, vol. 9, p. 113.	573
164	2*c*	**Sierra Blanca,** Huejuquilla or Jimenez, Chihuahua, Mexico. The occurrence at Sierra Blanca was recorded in 1784: the only specimen known—that from the Bergemann collection—is now thought to be of doubtful authenticity; in its etched figures it is like Toluca.	Mineralog. Magazine, 1890, vol. 9, p. 149.	47
165	2*c*	**Concepcion:** (Huejuquilla or Jimenez, Chihuahua, Mexico). Masses of iron, some of them probably belonging to one fall, have been known for centuries to exist near Huejuquilla: the mass is said to have been transported to Concepcion from Sierra de las Adargas in 1780.	Mineralog. Magazine, 1890, vol. 9, p. 140.	15
166	2*c*	**Chupaderos,** Chihuahua, Mexico. Mentioned to Bartlett in 1852.	Mineralog. Magazine, 1890, vol. 9, p. 148.	1,087
167	2*c*	**Casas Grandes** (de Malintzin), Chihuahua, Mexico. Reported by Tarayre in 1867.	Mineralog. Magazine, 1890, vol. 9, p. 119.	990
168	2*c*	**Moctezuma,** Sonora, Mexico.		170
169	2*c*	**Arispe,** Sonora, Mexico. Found in 1898: described by Ward in 1902 and Wuensch in 1903.	Proc. Rochester Ac. Sci. 1902, vol. 4, p. 79. Proc. Colorado Sci. Soc. 1903, vol. 7, p. 67.	1,910

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
170	2*c*	**El Ranchito,** Bacubirito, Sinaloa, Mexico. Found in 1871: described by Castillo in 1889.	Mineralog. Magazine, 1890, vol. 9, p. 151.	1,085
171	1*a*	**Rancho de la Pila,** Labor de Guadalupe, Durango, Mexico. Ploughed up in 1882: described by Häpke in 1883.	Mineralog. Magazine, 1890, vol. 9, p. 153.	46,512
172	2*c*	**Cacaria,** Durango, Mexico. Reported by Castillo in 1889.	Mineralog. Magazine, 1890, vol. 9, p. 154.	310
173	2*b*	**San Francisco del Mezquital,** Durango, Mexico. Brought from Mexico by General Castelnau, and described in 1868 by Daubrée. The above is the old name for the capital of Mezquital.	Mineralog. Magazine 1890, vol. 9, p. 154.	7,120
174	2*c*	**Bella Roca,** Sierra de San Francisco, Santiago Papasquiaro, Durango, Mexico. Acquired by Ward in 1888: described by Whitfield in 1889.	Amer. Jour. Sci. 1889, ser. 3, vol. 37, p. 439.	3,542
175	2*c*, 2*p*	**Descubridora,** Catorce, San Luis Potosi, Mexico. Found before 1780, and described by a committee in 1872.	Mineralog. Magazine, 1890, vol. 9, p. 157.	4,459
176	4*l*	**Charcas,** San Luis Potosi, Mexico. Mentioned in 1804 by Sonneschmid; it was then at the corner of the church, and was said to have been brought from San José del Sitio, 12 leagues distant. In 1866 it was removed to Paris.	Mineralog. Magazine, 1890, vol. 9, p. 160.	332
177	2*c*, 4*l*	**Zacatecas,** Mexico. Mentioned in 1792; it was said to have been found long before near the Quebradilla Mine.	Mineralog. Magazine, 1890, vol. 9, p. 162.	3,846
178	1*a* 2*c* 4*l*	**Toluca,** Mexico. Before 1776 it was known that masses of iron occurred in the neighbourhood of Xiquipilco, Valley of Toluca.	Mineralog. Magazine, 1890, vol. 9, p. 164.	106,547
179	2*c*	**Cuernavaca,** Morelos, Mexico. Mentioned by Castillo in 1889.	Mineralog. Magazine, 1890, vol. 9, p. 168.	1,025

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
180	2*c*	**Yanhuitlan,** Misteca alta, Oaxaca, Mexico. Mentioned by Del Rio in 1804.	Mineralog. Magazine, 1890, vol. 9, p. 171.	316
181	2*c*	**Apoala,** Oaxaca, Mexico. Found in 1890.		283
182	2*d*	**Rosario,** Honduras, Central America. Found in 1897.		128
183	Dr.	**Lucky Hill,** St. Elizabeth, Jamaica. Found in 1885 about 2 feet below the surface.		Rusted.
184	2*d*	**Santa Rosa** (Tocavita), near Tunja, Boyaca River, New Granada, S. America. In 1824 Rivero and Boussingault made known a large mass of iron in use as an anvil at Santa Rosa: with other small pieces it had been found on a neighbouring hill, called Tocavita, in 1810: they collected several specimens themselves.	Ann. Chim. Phys. 1824, vol. 25, p. 438.	101
185	2*d*	**Rasgata,** New Granada, S. America. Other masses of iron were seen by Rivero and Boussingault at Rasgata, and were said to have been found there.	Ann. Chim. Phys. 1824, vol. 25, p. 442.	58
186	2*d*	**Tarapaca,** Chili, S. America. Known since 1894.		14
187	2*d*	**La Primitiva,** Desert of Tarapaca, Chili, S. America. Known in 1888: mentioned by Howell in 1890.	Proc. Rochester Ac. Sci. 1890, vol. 1, p. 100.	78
188	2*a*	**Mount Hicks,** Mantos Blancos, about 40 miles from Antofagasta, Atacama, Chili. Found about 1876, and described by L. F. in 1889.	Mineralog. Magazine, 1889, vol. 8, p. 257.	9,015
189	2*d*	**Serrania de Varas,** Atacama, Chili. Found about 1875, and described by L. F. in 1889.	Mineralog. Magazine, 1889, vol. 8, p. 258.	1,168
190	2*d*	**San Cristobal,** Antofagasta, Atacama, Chili. Known since 1896: described by Cohen in 1898.	Sitzungsb. d. k. preuss. Ak. d. Wissens. zu Berlin, 1898, I, p. 607.	145

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
191	*2d*	**Cachiyuyal,** Atacama, Chili. Found in 1874: described by Domeyko in 1875.	Mineralog. Magazine, 1889, vol. 8, p. 259.	28
192	*2d*	**Ilimaë,** Atacama, Chili. Known since 1870: described by Tschermak in 1872.	Mineralog. Magazine, 1889, vol. 8, p. 260.	39
193	*2d*	**Merceditas,** 10 or 12 leagues East of Chañaral, Atacama, Chili. Known since 1884: described by Howell in 1890.	Proc. Rochester Ac. of Sc. 1890, vol. 1, p. 99.	1,917
194	*2p*	**Pan de Azucar,** Atacama, Chili. Found about 67 miles from the port of Pan de Azucar in 1887.		20,250
195	*2d*	**Juncal,** Atacama, Chili. Found in 1866 between Rio Juncal and the Salinas de Pedernal: had possibly been transported to that place: described by Daubrée in 1868.	Mineralog. Magazine, 1889, vol. 8, p. 261.	75
196	*2d*	**Puquios,** Copiapo, Atacama, Chili. Found about 1885: described by Howell in 1890.	Proc. Rochester Ac. of Sc. 1890, vol. 1, p. 89.	176
197	*2d*	**The Joel Iron,** Atacama, Chili. Found in 1858 in an unspecified part of the desert: described by L. F. in 1889.	Mineralog. Magazine, 1889, vol. 8, p. 263.	1,144
198	*2d*	**Sierra de la Ternera,** Atacama, Chili. Described by Kunz and Weinschenk in 1891.	Tschermak's Min. u. Petrog. Mitth. 1891, vol. 12, p. 184.	5
199	*2d*	**Barranca Blanca,** between Copiapo and Catamarca, South America. Found in 1855, and described by L. F. in 1889.	Mineralog. Magazine, 1889, vol. 8, p. 262.	11,915
200	*2d*	**Chili.** Owing to an interchange of labels, the specimen was described in 1868 by Daubrée as having been found in an unspecified locality in Chili. According to Domeyko it was supposed to have been found in the Cordillera de la Dehesa, near Santiago.	Mineralog. Magazine, 1889, vol. 8, p. 256.	2

No.	Pane.	Name of Meteorite and Place of Find	Report of Find.	Weight in grams.
201	Sep. Stand, 4*c*	**Otumpa,** Gran Chaco Gualamba, Argentine Republic. The occurrence of metallic iron at this locality having been reported, Don Rubin de Celis was sent in 1783 to investigate the matter: his report was published in 1788.	Phil. Trans. 1788, vol. 78, pp. 37, 183. Mineralog. Magazine, 1889, vol. 8, p. 229.	637,000
202	2*d*	**Bendegó River,** Bahia, Brazil. Found in 1784: described by Mornay in 1816.	Phil. Trans. 1816, vol. 106, p. 270.	3,115
203	2*d*	**Santa Catharina** (Morro do Rocio), Rio San Francisco do Sul, Brazil. Discovered in 1875: described by Lunay in 1877: it is regarded by some mineralogists as probably of terrestrial origin.	Comptes Rendus, 1877, vol. 85, p. 84.	6,399
204	2*d*	**Caperr,** Rio Senguerr, Patagonia. Known before 1869: described by L. F. in 1899.	Mineralog. Magazine, 1900, vol. 12, p. 167.	56
205	2*d*	**Locality unknown** (from Prof. Wöhler's Collection). Described by Wöhler in 1852.	Ann. Chem. Pharm. 1852, vol. 81, p. 253.	30
206	2*d*	**Locality unknown** (from Smithsonian Museum Collection). Described by Shepard in 1881.	Amer. Jour. Sc. 1881, ser. 3, vol. 22, p. 119.	5
207	2*d*	**Locality unknown** (from United States National Museum Collection). Slice of a complete meteorite which was found in a collection of minerals formed by the late Col. J. J. Abert: described by Riggs in 1887.	Amer. Jour. Sc. 1887, ser. 3, vol. 34, p. 59.	47

II. SIDEROLITES,

(consisting chiefly of nickeliferous iron and silicates, both in large proportion).

A. Fall Recorded.

[Arranged chronologically.]

No.	Pane.	Name of Meteorite and Place of Fall.	Date of Fall.	Weight in grams.
208	2*e*	**Taney County,** Missouri, U.S.A. . . A fragment, sent from Taney County, Missouri, about 1857-8, was described by Shepard in 1860. *Amer. Jour. Sc.* 1860, ser. 2, vol. 30, p. 205. A fragment of a meteorite was given to Cox by Judge Green of Crawford County: no mention of place or date of find. *Sec. Rep. Geol. Reconn. Arkansas*, 1860, p. 408. Green's fragment was described under the name of Newton County (Arkansas) by Smith in 1865. *Amer. Jour. Sc.* 1865, ser. 2, vol. 40, p. 213. A large mass was obtained by Kunz and reported by him in 1887 to have really fallen in Taney County, Missouri, about thirty years before, and to have been afterwards taken to Newton County, Arkansas. *Amer. Jour. Sc.* 1887, ser. 3, vol. 34, p. 467.	Fell about 1857-8.	2,404
209	2*e*	**Lodran** (Lodhran), Mooltan, Punjaub, India.	Oct. 1, 1868.	58
210	2*a*	**Estherville,** Emmet County, Iowa, U.S.A.	May 10, 1879.	116,903
211	2*e*	**Veramin,** Teheran, Persia	May, 1880.	238
212	2*e*	**Marjalahti,** Viborgs Län, Finland .	June 1, 1902.	2,990

B. Fall not Recorded.

[Arranged topographically.]

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
213	2*e*	**Finmarken,** Norway. Found in 1902: described by Cohen in 1903.	Mittheil. naturw. Verein für Neu-Vorpommern und Rügen, Jahrg. 35, 1903, p. 1.	1,307
214	2*e*	**Hainholz,** Minden, Westphalia. Found in 1856: described by Wöhler in 1857.	Pogg. Ann. 1857, vol. 100, p. 342.	484
215*a*	2*e*	**Steinbach,** Erzgebirge, Saxony. Reported as "native iron" by J. G. Lehmann in 1751.	Kurze Einleitung in einige Theile der Bergwerks-Wissenschaft, 1751, p. 79.	132
215*b*	2*e*	**Rittersgrün,** Erzgebirge, Saxony. Found in (1833 or) 1847: reported by Breithaupt in 1861. According to Weisbach it was really found in 1833.	Zeitsch. deutsch. geol. Gesell. 1861, vol. 13, p. 148. Der Eisenmeteorit von Rittersgrün im sächsischen Erzgebirge: von A. W.: Freiberg, 1876.	694
215*c*	2*e*	**Breitenbach,** Erzgebirge, Bohemia. Found in 1861: described by Maskelyne in 1871. Steinbach, Rittersgrün, and Breitenbach are within five English miles of each other, on the border of Saxony and Bohemia; the siderolites probably fell at the same time. Breithaupt suggests that this was the fall reported to have taken place at Whitsuntide in the year 1164: Buchner (p. 124) suggests a fall which took place between 1540 and 1550.	Phil. Trans. 1871, vol. 161, p. 359. Berg-und hütt. Zeitung, 1862, Jahrg. 21, p. 321.	6,231
216	2*e*	**Brahin,** Minsk, Russia. Found in 1809, 1810 or 1820.	Bull. des. Sc. par la Soc. philom., *Paris*, 1823, p. 86. Partsch's Die Meteoriten zu Wien. 1843, p. 90. Erman's Archiv. f. wiss. Kunde von Russland, 1846, vol. 5, p. 183.	22

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
217	2e,4c	**The Pallas iron.** Found in 1749 between the Ubei and Sisim rivers, Jeniseisk, Asiatic Russia, and transported to Krasnojarsk: reported by Pallas in 1776.	Reise d. versch. Prov. d. russ. Reichs: von P. S. Pallas. St. Petersburg, 1776. Part iii. p. 411.	3,735
218	2e	**Pavlodar,** Semipalatinsk, Asiatic Russia. Found in 1885.		56
219	2e	**Senegal River,** West Africa. "Native Iron" was found by Compagnon in 1716 to be in very common use in many parts of the kingdoms of Bambuk and Siratik.	Allgemeine Historie der Reisen zu Wasser und Lande: von J. J. Schwabe. Leipzig, 1748, vol. 2, Book 5, Ch. 13, p. 510.	396
220	2e	**Mount Dyrring,** Bridgman, Singleton District, New South Wales. Found in 1902: described by Card in 1903.	Records of the Geol. Survey of N. S. Wales, 1903, vol. 7, p. 218.	249
221	2e	**Powder Mill Creek,** Cumberland County, Tennessee, U.S.A. Found in 1887: described in the same year by Whitfield and Kunz.	Amer. Jour. Sc. 1887, ser. 3, vol. 34, pp. 387, 476.	1,148
222	2e	**Eagle Station,** Carroll County, Kentucky, U.S.A. Found in 1880, and described by Kunz in 1887.	Amer. Jour. Sc. 1887, ser. 3, vol. 33, p. 228.	708
223	2e	**Brenham Township,** Kiowa County, Kansas, U.S.A. Found about 1886: described by Kunz in 1890.	Amer. Jour. Sc. 1890, ser. 3, vol. 40, p. 312.	2,011
224	2e	**Admire,** Lyon County, Kansas, U.S.A. Found about 1892: described by Merrill in 1902.	Proc. U.S. Nat. Mus. 1902, vol. 24, p. 907.	1,078
225	Sep. Stand, 2f	**Imilac,** Atacama, Chili. Known in 1822: probably the specimen found at Campo de Pucará in 1879 had been carried at some time or other from Imilac.	Mineralog. Magazine, 1889, vol. 8, p. 243.	227,328
226	2f	**Vaca Muerta,** Atacama, Chili. Mentioned in 1861, and described in 1864 by Domeyko as found at Sierra de Chaco. Specimens probably got from the same place are known by various names (Mejillones, Jarquera or Janacera Pass, &c.).	Mineralog. Magazine, 1889, vol. 8, p. 234.	7,283

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
227	2*f*	**Llano del Inca,** 35 leagues S.E. of Taltal, Atacama, Chili.	Proc. Rochester Ac. of Sci. 1890, vol. 1, p. 93.	376
228	2*f*	**Doña Inez,** Atacama, Chili. The meteorites of Llano del Inca and Doña Inez were found in these localities in 1888, and were described by Howell in 1890: "polished sections of the two meteorites are in many cases not distinguishable," and Howell is inclined to think that they belong to a single fall. (Some of the polished faces are not to be distinguished from those of Vaca Muerta.) L. F.	*Ibid.*	1,016
229	2*f*	**Copiapo,** Chili. Numerous masses of this type have been brought to Copiapo since 1863: some of them, owing to an interchange of labels, have been supposed to come from the Sierra de la Dehesa (Deesa), near Santiago.	Mineralog. Magazine, 1889, vol. 8, p. 255.	769

III. AEROLITES

or Meteoric Stones,

(consisting generally of one or more silicates, and interspersed particles of nickeliferous iron, troilite, &c.).

A. Fall Recorded.

[Arranged chronologically.]

No.	Pane.	Name of Meteorite and Place of Fall.	Date of Fall.	Weight in grams.
230	4*c*	**Ensisheim,** Elsass, Germany . .	Nov. 16, 1492	458
231	2*g*	**Schellin,** near Stargard, Pomerania, Prussia.	April 11, 1715	—
232	2*g*	**Plescowitz,** near Reichstadt, Bohemia .	June 22, 1723	25
233	4*c*	**Ogi,** Hizen, Kiusiu, Japan . . .	Fell about 1730	4,185
234	4*c*	**Tabor** (Krawin Plan, Strkow), Bohemia	July 3, 1753	151
235	2*g*	**Luponnas,** Ain, France . . .	Sept. 7, 1753	7
236	2*g*	**Albareto,** Modena, Italy . . .	July 1766	53
237	4*c*	**Lucé** (Maine), Sarthe, France . .	Sept. 13, 1768	11
238	2*g*	**Mauerkirchen,** Upper Austria . .	Nov. 20, 1768	302
239	2*g*	**Sena,** Sigena, Aragon, Spain . .	Nov. 17, 1773	0·7
240	2*g*	**Eichstädt,** Wittmess, Bavaria . .	Feb. 19, 1785	46
241	2*g*	**Kharkov** (Jigalowka, Bobrik), Russia .	Oct. 12 (not 13), 1787	437
242	2*g*	**Barbotan:** (*a*) Barbotan, (*b*) Roquefort, } Landes, France	July 24, 1790	{712 {145
243	4*c*	**Siena,** Cosona, Italy	June 16, 1794	128
244	4*b*	**Wold Cottage,** Thwing, Yorkshire .	Dec. 13, 1795	20,111
245	2*g*	**Bjelaja Zerkov,** Kiev, Russia . .	Jan. 15 or 16, 1796	9
246	2*g*	**Salles,** near Villefranche, Rhône, France	March 8 or 12, 1798	165
247	2*g*, 4*c*	**Krakhut,** Benares, India . . .	Dec. 19, 1798	510
248	2*h*, 4*c*	**L'Aigle,** Orne, France. . . .	April 26, 1803	2,242
249	2*h*	**Apt** (Saurette), Vaucluse, France . .	Oct. 8, 1803	37
250	2*h*	**Mässing** (St. Nicholas), Bavaria . .	Dec. 13, 1803	—
251	2*h*	**Darmstadt,** Hesse, Germany . .	Fell before 1804	1·6
252	4*d*	**High Possil,** near Glasgow, Scotland .	April 5, 1804	91
253	2*h*	**Hacienda de Bocas,** San Luis Potosi, Mexico.	Nov. 24, 1804	—
254	2*h*	**Doroninsk,** Irkutsk, Asiatic Russia .	April 6, 1805	8
255	2*h*	**Asco,** Corsica	Nov. 1805	—
256	4*n*	**Alais,** Gard, France	March 15, 1806	13
257	2*h*	**Timochin,** Juchnov, Smolensk, Russia.	March 25, 1807	138
258	2*h*, 4*o*	**Weston,** Fairfield County, Connecticut, U.S.A.	Dec. 14, 1807	1,034
259	2*h*	**Borgo San Donino,** Cusignano, Parma, Italy.	April 19, 1808	9

No.	Pane.	Name of Meteorite and Place of Fall.	Date of Fall.	Weight in grams.
260	2h, 4d, 4o	**Stannern:** (a) Stannern, (b) Langenpiernitz, Iglau, Moravia, Austria.	May 22, 1808	1,570; 13
261	2h	**Lissa,** Bunzlau, Bohemia . . .	Sept. 3, 1808	169
262	2h	**Moradabad,** North-West Provinces, India.	Fell in 1808	17
263	2h	**Kikino,** Viasma, Smolensk, Russia .	Fell in 1809	25
264	2h	**Mooresfort,** County Tipperary, Ireland.	Aug. 1810	243
265	2h	**Charsonville:** (a) Charsonville, (b) Bois de Fontaine, (c) Fragment of a stone labelled *Chartres.* Meung, Loiret, France.	Nov. 23, 1810	108; 2,227; 20
266	2h	**Kuleschovka,** Poltava, Russia . .	March 12, 1811	57
267	2h	**Berlanguillas,** near Burgos, Spain .	July 8, 1811	26
268	2k	**Toulouse** (Grenade), Haute Garonne, France.	April 10, 1812	31
269	2k	**Erxleben,** Magdeburg, Prussia . .	April 15, 1812	31
270	2k, 4o	**Chantonnay,** Vendée, France . .	Aug. 5, 1812	1,352
271	2k	**Limerick** (Adare, Faha, &c.), Ireland .	Sept. 10, 1813	113
272	2k	**Luotolaks,** Viborg, Finland . .	Dec. 13, 1813	20
273	2k	**Gurram Konda,** between Punganur and Kadapa, Madras, India.	Fell in 1814	9
274	2k	**Bachmut** (Alexejevka), Ekaterinoslav, Russia.	Feb. 15, 1814	40
275	2k	**Agen,** Lot-et-Garonne, France . .	Sept. 5, 1814	40
276	2k	**Chail,** Allahabad, North-West Provinces, India.	Nov. 5, 1814	—
277	2k	**Durala,** N.W. of Kurnal, Punjaub, India	Feb. 18, 1815	12,000
278	4o	**Chassigny,** Haute Marne, France .	Oct. 3, 1815	41
279	2k	**Zaborzika,** Czartorya, Volhynia, Russia	April 11 (not 10), 1818	9
280	4n	**Seres,** Macedonia, Turkey . . .	June 1818	399
281	2k	**Slobodka,** Juchnov, Smolensk, Russia .	Aug. 10, 1818	27
282	2l	**Jonzac,** Charente Inférieure, France .	June 13, 1819	9
283	2l	**Pohlitz,** near Gera, Reuss, Germany .	Oct. 13, 1819	86
284	2l	**Lixna** (Lasdany), Dünaburg, Vitebsk, Russia.	July 12, 1820	59
285	4o	**Juvinas,** near Libonnez, Ardèche, France	June 15, 1821	940
286	2l	**Angers,** Maine-et-Loire, France . .	June 3, 1822	22
287	2l	**Agra** (Kadonah), India . . .	Aug. 7, 1822	38
288	2l	**Epinal** (La Baffe), Vosges, France .	Sept. 13, 1822	1·6
289	2l, 4h	**Futtehpur** (Fatehpur): (a) Futtehpur, (b) Bithur, N. West Provinces, India	Nov. 30, 1822	1,286; 136
290	2l	**Umballa** (40 miles S.W. of), Punjaub, India.	Fell in 1822–3	20
291	2l	**Nobleborough,** Lincoln County, Maine, U.S.A.	Aug. 7, 1823	—

No.	Pane.	Name of Meteorite and Place of Fall.	Date of Fall.	Weight in grams.
292	2*l*	**Renazzo,** Cento, Ferrara, Italy . .	Jan. 15, 1824	15
293	2*l*	**Zebrak** (Praskoles), near Horzowitz, Bohemia.	Oct. 14, 1824	83
294	2*l*	**Nanjemoy,** Charles County, Maryland, U.S.A.	Feb. 10, 1825	325
295	2*l*	**Honolulu,** Hawaii, Sandwich Islands .	Sept. 27, 1825	81
296	2*m*	**Pavlograd**(Mordvinovka), Ekaterinoslav, Russia.	May 19, 1826	160
297	2*m*	**Mhow,** Azamgarh District, North-West Provinces, India.	Feb. 16, 1827	163
298	2*m*	**Drake Creek,** Nashville, Tennessee, U.S.A.	May 9, 1827	19
299	2*m*	**Bialystock** (Jasly), Grodno, Russia .	Oct. 5, 1827	3
300	2*m*	**Richmond,** Henrico County, Virginia, U.S.A.	June 4, 1828	169
301	2*m*	**Forsyth,** Georgia, U.S.A. . . .	May 8, 1829	72
302	2*m*	**Deal,** near Long Branch, New Jersey, U.S.A.	Aug. 14, 1829	—
303	2*m*	**Krasnoi-Ugol,** Rjäsan, Russia . .	Sept. 9, 1829	—
304	2*m*	**Launton,** Bicester, Oxfordshire . .	Feb. 15, 1830	1,022
305	2*m*	**Perth** (North Inch of), Scotland . .	May 17, 1830	1·5
306	2*m*	**Vouillé,** near Poitiers, Vienne, France .	May 13, 1831	60
307	2*m*	**Wessely** (Znorow), Hradisch, Moravia, Austria.	Sept. 9, 1831	3
308	2*m*	**Blansko,** Brünn, Moravia, Austria .	Nov. 25, 1833	—
309	2*m*	**Okniny,** Kremenetz, Volhynia, Russia .	Jan. 8, 1834	7
310	2*m*	**Charwallas** (Chaharwala), near Hissar, Delhi, India.	June 12, 1834	37
311	2*m*	**Mascombes,** Corrèze, France . .	Jan. 31, 1835	5
312	2*m*	**Aldsworth,** near Cirencester, Gloucestershire.	Aug. 4, 1835	525
313	2*m*	**Aubres,** Nyons, Drôme, France . .	Sept. 14, 1836	488
314	2*m*	**Macao,** Rio Grande do Norte, Brazil .	Nov. 11, 1836	6
315	2*m*	**Nagy-Diwina,** near Budetin, Trentschin, Hungary.	July 24, 1837	3
316	2*m*	**Esnandes,** Charente Inférieure, France.	Aug. 1837	3
317	2*n*	**Kaee,** Sandee District, Oude, India .	Jan. 29, 1838	209
318	2*n*	**Akbarpur,** Saharanpur, North-West Provinces, India.	April 18, 1838	1,568
319	2*n*	**Chandakapur,** Berar, India . .	June 6, 1838	760
320	2*n*	**Montlivault,** Loir-et-Cher, France .	July 22, 1838	11
321	2*n*, 4*n*	**Cold Bokkeveld,** Cape Colony .	Oct. 13, 1838	1,078
322	2*n*	**Little Piney** (Pine Bluff), Pulaski County, Missouri, U.S.A.	Feb. 13, 1839	103
323	2*n*	**Karakol,** Ajagus, Kirghiz Steppes, Russia.	May 9, 1840	24
324	2*n*	**Uden** (Staartje), North Brabant, Netherlands.	June 12, 1840	5
325	2*n*	**Cereseto,** near Ottiglio, Alessandria, Piedmont, Italy.	July 17, 1840	124

No.	Pane.	Name of Meteorite and Place of Fall.	Date of Fall.	Weight in grams.
326	2*n*	**Grüneberg,** Heinrichsau, Prussian Silesia	March 22, 1841	30
327	2*n*	**Château-Renard,** Triguères, Loiret, France.	June 12, 1841	3,290
328	2*n*	**Milena,** Warasdin, Croatia, Austria .	April 26, 1842	25
329	2*n*	**Aumières,** Lozère, France . . .	June 3, 1842	43
330	4*o*	**Bishopville,** Sumter County, S. Carolina, U.S.A.	March 25, 1843	509
331	2*n*, 4*n*	**Utrecht** (Blaauw-Kapel), Netherlands .	June 2, 1843	69
332	2*n*	**Manegaum** (Manegaon), near Eidulabad, border of Khandeish, India.	June 29, 1843	11
333	2*n*	**Klein-Wenden,** near Nordhausen, Erfurt, Prussia.	Sept. 16, 1843	5
334	2*n*	**Cerro Cosina,** near Dolores Hidalgo, San Miguel, Guanaxuato, Mexico.	Jan. 1844	42
335	2*n*	**Killeter,** County Tyrone, Ireland . .	April 29, 1844	104
336	2*n*	**Favars,** Aveyron, France . . .	Oct. 21, 1844	6
337	2*n*	**Le Teilleul** (La Vivionnère), Manche, France.	July 14, 1845	1·9
338	2*n*	**Monte Milone** (now called Pollenza), Macerata, Italy.	May 8, 1846	8
339	2*n*	**Cape Girardeau,** Missouri, U.S.A.	Aug. 14, 1846	78
340	2*n*	**Schönenberg,** Mindelthal, Schwaben, Bavaria.	Dec. 25, 1846	42
341	2*o*	**Linn County** (Hartford), Iowa, U.S.A.	Feb. 25, 1847	942
342	2*o*	**Castine,** Hancock County, Maine, U.S.A.	May 20, 1848	2
343	2*o*	**Marmande** (Montignac), Aveyron, France.	July 4, 1848	4
344	2*o*	**Ski,** Amt Akershuus, Norway . .	Dec. 27, 1848	5
345	2*o*	**Cabarras County** (Monroe), N. Carolina, U.S.A.	Oct. 31, 1849	385
346	2*o*	**Kesen,** Japan	June 13, 1850	1,281
347	2*o*	**Shalka,** Bancoorah, Bengal, India . .	Nov. 30, 1850	1,132
348	2*o*	**Gütersloh,** Westphalia, Prussia . .	April 17, 1851	109
349	2*o*	**Quinçay,** Vienne, France . . .	Summer, 1851	10
350	2*o*	**Nulles,** Catalonia, Spain . . .	Nov. 5, 1851	27
351	4*p*	**Nellore** (Yatur), Madras, India . .	Jan. 23, 1852	10,420
352	2*o*, 4*d*	**Mezö-Madaras,** Transylvania . .	Sept. 4, 1852	733
353	2*o*	**Borkut,** Marmoros, Hungary . .	Oct. 13, 1852	40
354	4*o*	**Bustee** (Basti), between Goruckpur and Fyzabad, India.	Dec. 2, 1852	1,000
355	2*o*	**Girgenti,** Sicily	Feb. 10, 1853	233
356	2*o*	**Segowlie,** Bengal, India . . .	March 6, 1853	1,205
357	2*o*	**Duruma,** Wanikaland, E. Africa . .	Fell in 1853	1·2
358	2*o*	**Linum,** Brandenburg, Prussia . .	Sept. 5, 1854	2
359	3*c*	**Oesel** (Gesinde Kaande, near Piddul), Baltic Sea.	May 11, 1855	17
360	3*c*	**Gnarrenburg** (Bremervörde), Hanover	May 13, 1855	808
361	3*c*	**St. Denis - Westrem,** near Ghent, Belgium.	June 7, 1855	1·3

No.	Pane.	Name of Meteorite and Place of Fall.	Date of Fall.	Weight in grams.
362	4*o*	**Petersburg,** Lincoln County, Tennessee, U.S.A.	Aug. 5, 1855	51
363	3*c*	**Trenzano,** Brescia, Italy . . .	Nov. 12, 1856	157
364	3*c*, 3*a*	**Parnallee,** Madras, India . . .	Feb. 28, 1857	61,361
365	3*c*	**Heredia,** San José, Costa Rica . .	April 1, 1857	54
366	3*c*	**Stavropol,** north side of the Caucasus, Russia.	April 5, 1857	22
367	3*c*	**Kaba,** Debreczin, Hungary . . .	April 15, 1857	104
368	3*c*	**Les Ormes,** near Joigny, Yonne, France	Oct. 1, 1857	12
369	3*c*	**Ohaba** (Veresegyhaza), near Karlsburg, Transylvania.	Oct. 11, 1857	39
370	4*n*	**Pegu** (Quenggouk), British Burmah .	Dec. 27, 1857	654
371	3*c*	**Kakowa,** Temeser Banat, Hungary .	May 19, 1858	160
372	3*c*	**Ausson:** (*a*) Ausson, (*b*) Clarac, Haute Garonne, France.	Dec. 9, 1858	367 110
373	3*c*	**Molina,** Murcia, Spain	Dec. 24, 1858	6
374	3*d*	**Harrison County,** Indiana, U.S.A. .	March 28, 1859	38
375	3*d*	**Pampanga** (Mexico), Philippine Islands	April 4, 1859	1·8
376	3*d*	**Beuste,** near Pau, Basses-Pyrénées, France.	May 1859	40
377	3*d*	**Bethlehem,** near Albany, New York, U.S.A.	Aug. 11, 1859	—
378	3*d*	**Alessandria** (San Giuliano Vecchio), Piedmont, Italy.	Feb. 2, 1860	35
379	4*n*	**Khiragurh,** S.E. of Bhurtpur, India .	March 28, 1860	353
380	3*d*, 3*b*	**New Concord,** Muskingum County, Ohio, U.S.A.	May 1, 1860	19,519
381	3*d*	**Kusiali,** Kumaon, India . . .	June 16, 1860	4
382	3*c*	**Dhurmsala** (Dharmsala), Kangra, Punjaub, India.	July 14, 1860	12,407
383	4*h*	**Butsura** (Batsura) (Qutahar Bazaar) (Chireya) (Piprassi) (Bulloah) Bengal, India.	May 12, 1861	13,071 843 5,060 158
384	3*d*	**Canellas,** near Barcelona, Spain . .	May 14, 1861	1·5
385	3*d*	**Grosnaja** (Mikenskoi), Banks of the Terek, Caucasus, Russia.	June 28, 1861	160
386	3*d*	**Klein-Menow,** Alt-Strelitz, Mecklenburg, Germany	Oct. 7, 1862	1,132
387	3*d*	**Pulsora,** N.E. of Rutlam, Indore, Central India.	March 16, 1863	48
388	3*d*	**Buschhof** (Scheikahr Stattan), Courland, Russia.	June 2, 1863	98
389	3*d*	**Pillistfer** (Aukoma), Livland, Russia .	Aug. 8, 1863	157
390	3*d*	**Shytal** (Shaital), 40 miles north of Dacca, India.	Aug. 11, 1863	462
391	3*d*	**Tourinnes-la-Grosse,** Tirlemont, Belgium.	Dec. 7, 1863	203
392	3*d*	**Manbhoom,** Bengal, India. . .	Dec. 22, 1863	122
393	3*d*	**Nerft,** Courland, Russia . . .	April 12, 1864	69

No.	Pane.	Name of Meteorite and Place of Fall.	Date of Fall.	Weight in grams.
394	3d, 4d	**Orgueil,** near Montauban, Tarn-et-Garonne, France.	May 14, 1864	621
395	3d	**Dolgovoli,** Volhynia, Russia . .	June 26, 1864	1·5
396		**Supuhee:**	Jan. 19, 1865	
	3e	(a) Mouza Khoorna, Sidowra, } Goruckpur District, India.		4,050
	4h	(b) Bubuowly Indigo Factory, Supuhee,		200
397	3e	**Vernon County,** Wisconsin, U.S.A. .	March 26, 1865	52
398	3e	**Gopalpur,** Jessore, India . . .	May 23, 1865	147
399	3e	**Dundrum,** Tipperary, Ireland . .	Aug. 12, 1865	245
400	3e	**Aumale** (Senhadja), Constantine, Algeria	Aug. 25, 1865	34
401	4k, 4o	**Sherghotty** (Umjhiawar), near Gya, Behar, India.	Aug. 25, 1865	116
402	4n	**Muddoor,** Mysore, India . . .	Sept. 21, 1865	407
403	3e	**Udipi** (Yedabettu), South Canara, India	April 1866	3,306
404	3e	**Pokhra,** near Bustee, Goruckpur, India .	May 27, 1866	45
405	3e	**St. Mesmin,** Aube, France. . .	May 30, 1866	109
406	3d, 4d, 4h, 4n	**Knyahinya,** near Nagy-Berezna, Hungary.	June 9, 1866	13,053
407	3e	**Jamkheir,** Ahmednuggur, Bombay .	Oct. 5, 1866	18
408	3e	**Cangas de Onis** (Elgueras), Asturias, Spain	Dec. 6, 1866	96
409	3e	**Khetri** (Saonlod, Sankhoo, Phulee, &c.), Rajpootana, India.	Jan. 19, 1867	13
410	4o	**Tadjera,** near Guidjel, Setif, Algeria .	June 9, 1867	39
411	3e, 4e-g	**Pultusk** (Siedlce, Gostków, &c.), Poland	Jan. 30, 1868	17,905
	3e	**Lerici,** Spezia, Italy	Jan. 30, 1868	8
412	3e, 4d	**Daniel's Kuil,** Griqualand, South Africa.	March 20, 1868	449
413	3e	**Slavetic,** Agram, Croatia, Austria .	May 22, 1868	20
414	3e	**Ornans,** Doubs, France . . .	July 11, 1868	1,018
415	3e	**Sauguis,** St. Étienne, Basses-Pyrénées, France.	Sept. 7, 1868	15
416	3e	**Danville,** Morgan County, Alabama, U.S.A.	Nov. 27, 1868	27
417	3e	**Frankfort** (4 miles S. of), Franklin County, Alabama, U.S.A.	Dec. 5, 1868	32
418	3e	**Moti-ka-nagla,** Ghoordha, Bhurtpur, [India.	Dec. 22, 1868	407
419	4o	**Angra dos Reis,** Rio de Janeiro, Brazil	Jan. 1869	6
420	3e, 4d	**Hessle,** near Upsala, Sweden . .	Jan. 1, 1869	910
421	3e	**Krähenberg,** Zweibrücken, Rhenish Bavaria.	May 5, 1869	11
422	3e	**Cléguérec** (Kernouvé), Morbihan, France.	May 22, 1869	9,346
423	3e	**Tjabé,** Padangan, Java . . .	Sept. 19, 1869	134
424	3e	**Stewart County** (12 miles S.W. of Lumpkin), Georgia, U.S.A.	Oct. 6, 1869	17
425	3f	**Ibbenbühren,** Westphalia, Prussia .	June 17, 1870	3
426	3f	**Cabeza de Mayo,** Murcia, Spain .	Aug. 18, 1870	3
427	4o	**Roda** (4 miles from), Huesca, Spain .	Spring 1871	7

No.	Pane.	Name of Meteorite and Place of Fall.	Date of Fall.	Weight in grams.
428	*3f*	**Searsmont,** Waldo County, Maine, U.S.A.	May 21, 1871	51
429	*3f*	**Laborel,** Drôme, France . . .	June 14, 1871	291
430	*3f*	**Bandong,** Java.	Dec. 10, 1871	14
431	*4d*	**Dyalpur,** Sultanpur, Oude, India . .	May 8, 1872	269
432	*3f*	**Tennasilm** (Sikkensaare), Esthonia, Russia.	June 28, 1872	15
433	*3f*	**Lancé:** {Authon and Lancé, Vendôme, Loir-et-Cher, France . . }	July 23, 1872	332
434	*4o*	**Orvinio,** near Rome, Italy . . .	Aug. 31, 1872	62
435	*3f*	**Jhung** (Jhang), Punjaub, India . .	June 1873	1,984
436	*3f*	**Khairpur,** 35 miles east of Bhawalpur, India.	Sept. 23, 1873	2,991
437	*3f*	**Santa Barbara,** Rio Grande do Sul, Brazil.	Sept. 26, 1873	1·7
438	*3f*	**Aleppo,** Syria	Fell about 1873	67
439	*3f*	**Sevrukovo,** near Belgorod, Kursk, Russia.	May 11, 1874	20
440	*3f*	**Nash County** (near Castalia), N. Carolina, U.S.A.	May 14, 1874	29
441	*3f*	**Virba,** Vidin, Turkey . . .	May 20, 1874	38
442	*3f*	**Kerilis,** Mael Pestivien, Côtes-du-Nord, France.	Nov. 26, 1874	74
443	*3f*	**West Liberty** (Homestead), Iowa County, Iowa, U.S.A.	Feb. 12, 1875	3,780
444	*3f*	**Sitathali** (Nurrah), S.E. of Raepur, Central Provinces, India.	March 4, 1875	600
445	*4d*	**Zsadány,** Temeser Banat, Hungary .	March 31, 1875	25
446	*3f*	**Nagaria,** Fathabad, Agra, India .	April 24, 1875	13
447	*3f*	**Mornans,** Bourdeaux, Drôme, France .	Sept. 1875	975
448	*4n*	**Judesegeri,** Kadaba Taluk, Mysore, India.	Feb. 16, 1876	114
449	*3g*	**Vavilovka,** Kherson, Russia . .	June 19, 1876	10
450	*3g*	**Ställdalen,** Nya Kopparberg, Orebro, Sweden.	June 28, 1876	1,563
451	*3g*	**Rochester,** Fulton County, Indiana, U.S.A.	Dec. 21, 1876	8
452	*3g*	**Warrenton,** Warren County, Missouri, U.S.A.	Jan. 3, 1877	82
453	*3g*	**Cynthiana** (9 miles from), Harrison County, Kentucky, U.S.A.	Jan. 23, 1877	154
454	*3g*	**Hungen,** Hesse, Germany . . .	May 17, 1877	5
455	*3g*	**Jodzie** (Yodzé), Ponevej, Kovno, Russia.	June 17, 1877	1·6
456	*3g*	**Soko-Banja** (Sarbanovac), N.E. of Alexinatz, Servia.	Oct. 13, 1877	1,975
457	*3g*	**Cronstad,** Orange River Colony, S. Africa.	Nov. 19, 1877	1,226
458	*3g*	**Bhagur** (Dhulia), India . . .	Nov. 27, 1877	10
459	*3h*	**Tieschitz,** Prerau, Moravia. . .	July 15, 1878	17
460	*3h*	**Dandapur,** Goruckpur, India . .	Sept. 5, 1878	2,245
461	*3h*	**Rakovka,** Tula, Russia . . .	Nov. 20, 1878	375
462	*3h*	**La Bécasse,** Dun le Poëlier, Indre, France	Jan. 31, 1879	19

No.	Pane.	Name of Meteorite and Place of Fall.	Date of Fall.	Weight in grams.
463	3*h*	**Itapicuru-mirim,** Maranhão, Brazil .	March 1879	6
464	3*h*	**Gnadenfrei,** Prussian Silesia . .	May 17, 1879	54
465	3*h*	**Nagaya,** Entre Rios, Argentine Republic.	July 1, 1879	31
466	3*h*	**Kalambi** (Kalumbi), Bombay, India .	Nov. 4, 1879	28
467	3*h*	**Tomatlan** (Gargantillo), Jalisco, Mexico	Sept. 17, 1879	135
468	3*h*	**Toke-uchi-mura,** Tamba, Japan .	Feb. 18, 1880	2
469	3*h*	**Middlesbrough** (Pennyman's Siding), Yorkshire.	March 14, 1881	25
470	3*h*	**Pacula,** Jacala, Hidalgo, Mexico. .	June 18, 1881	28
471	3*h*	**Gross-Liebenthal,** 12 miles S.S.W. of Odessa, Russia.	Nov. 19, 1881	62
472	3*h*, 3*k*, 4*d*	**Mocs,** Kolos, Transylvania . . .	Feb. 3, 1882	14,510
473	3*k*	**Fukutomi,** Hizen, Japan . . .	March 19, 1882	4
474	3*k*	**Pavlovka,** Balachev, Saratov, Russia .	Aug. 2, 1882	78
475	3*k*	**Pirgunje,** Dinagepur, India. . .	Aug. 29, 1882	734
476	3*k*	**Saint Caprais-de-Quinsac,** Gironde, France	Jan. 28, 1883	9
477	3*k*	**Alfianello,** Brescia, Italy . . .	Feb. 16, 1883	2,515
478	3*k*	**Ngawi,** Madioen, Java . . .	Oct. 3, 1883	52
479	3*l*	**Pirthalla,** Hissar District, Punjaub, India.	Feb. 9, 1884	427
480	3*l*	**Djati-Pengilon,** Alastoeva, Java .	March 19, 1884	469
481	3*l*	**Tysnes** (Midt-Vaage), Hardanger Fiord, Norway.	May 20, 1884	896
482	3*l*	**Chandpur,** 5 miles N.W. of Mainpuri, North-West Provinces, India.	April 6, 1885	490
483	3*l*	**Nammianthal,** South Arcot, Madras, India.	Jan. 27, 1886	1,623
484	3*l*	**Assisi,** Perugia, Italy	May 24, 1886	152
485	3*l*	**Alatyr** (Novo-Urei), Karamzinka, Petrovka, Nijni Novgorod, Russia.	Sept. 4, 1886	22
486	3*p*, 3*l*	**Yenshigahara,** Kita-isa, Kagoshima, Satsuma, Kiusiu, Japan.	Oct. 26, 1886	30,918
487	3*l*	**Bielokrynitschie,** Zaslavl, Volhynia, Russia.	Jan. 1, 1887	54
488	3*l*	**Lalitpur** (Jharaota), North-West Provinces, India.	April 7, 1887	82
489	3*l*	**Tabory,** Ochansk, Perm, Russia . .	Aug. 30, 1887	1,222
490	3*l*	**Lundsgård,** Ljungby, Sweden . .	April 3, 1889	214
491	3*l*	**Migheja,** Olviopol, Elizabetgrad, Kherson, South Russia.	June 21, 1889	87
492	3*l*	**Ergheo,** Brava, Somaliland . . .	July 1889	929
493	3*l*	**Jelica,** Servia	Dec. 1, 1889	1,879
494	3*m*	**Collescipoli** (Antifona), Terni, Italy .	Feb. 3, 1890	341
495	3*m*	**Baldohn,** Misshof, Courland, Russia .	April 10, 1890	134
496	3*m*	**Winnebago County** (Forest City), Iowa, U.S.A.	May 2, 1890	2,560
497	3*m*	**Kahangarai,** Tirupatúr, Salem, Madras, India.	June 4, 1890	122

No.	Pane.	Name of Meteorite and Place of Fall.	Date of Fall.	Weight in grams.
498	3*m*	**Nawapali,** Sambalpur District, Central Provinces, India.	June 6, 1890	21
499	3*m*	**Farmington,** Washington County, Kansas, U.S.A.	June 25, 1890	802
500	3*m*	**Indarh,** Elissavetpol, Transcaucasia .	April 7, 1891	42
501	3*m*	**Cross Roads,** Wilson County, N. Carolina, U.S.A.	May 24, 1892	11
502	3*m*	**Guareña,** Badajoz, Spain . . .	July 20, 1892	69
503	3*m*	**Bath,** S. Dakota, U.S.A. . . .	Aug. 29, 1892	2,119
504	3*m*	**Pricetown,** Highland County, Ohio, U.S.A.	Feb. 13, 1893	10
505	3*m*	**Bherai,** Junagadh, Kathiawar, Bombay	April 28, 1893	17
506	3*m*	**Beaver Creek,** West Kootenai District, British Columbia.	May 26, 1893	685
507	3*m*	**Zabrodje,** Wilna, Russia . . .	Sept. 22, 1893	3
508	3*m*	**Fisher,** Polk County, Minnesota, U.S.A.	April 9, 1894	602
509	3*m*	**Bori,** Badnúr, Betul District, Central Provinces, India.	May 9, 1894	1,270
510	3*m*	**Savtschenskoje,** Kherson, Russia .	July 27, 1894	62
511	3*m*	**Bishunpur** (and Parjabatpur), Mirzapur District, North-West Provinces, India.	April 26, 1895	393
512	3*m*	**Nagy-Borové,** Liptau, Hungary. .	May 9, 1895	53
513	3*m*	**Ambapur Nagla,** Sikandra Rao Tahsil, Aligarh District, North-West Provinces, India.	May 27, 1895	1,075
514	3*m*	**Madrid,** Spain	Feb. 10, 1896	18
515	3*m*	**Ottawa,** Franklin County, Kansas, U.S.A.	April 9, 1896	90
516	3*m*	**Lesves,** Namur, Belgium . . .	April 13, 1896	56
517	3*n*	**Meuselbach,** Thuringia, Germany .	May 19, 1897	19
518	3*n*	**Lançon,** Bouches-du-Rhône, France .	June 20, 1897	199
519	3*n*	**Zavid,** District Zwornik, Bosnia . .	Aug. 1, 1897	267
520	3*n*	**Higashi Koen,** Hakata, Chikuzen, Japan	Aug. 11, 1897	32
521	3*n*	**Gambat,** Khairpur State, Sind, India .	Sept. 15, 1897	1,752
522	3*n*	**Saline Township,** Sheridan County, Kansas, U.S.A.	Nov. 15, 1898(?)	160
523	3*n*	**Zomba,** British Central Africa . .	Jan. 25, 1899	2,254
524	3*n*	**Bjurböle,** Borgå, Finland . . .	March 12, 1899	152
525	3*n*	**Allegan,** Michigan, U.S.A. . .	July 10, 1899	764
526	3*n*	**Donga Kohrod,** Bilatpur, India .	Sept. 23, 1899	39
527	3*n*	**Sindhri,** Thar and Parkar District, Bombay, India.	June 10, 1901	1,201
528	3*n*	**Andover,** Oxford County, Maine, U.S.A.	Aug. 5, 1901	20
529	3*n*	**Hvittis,** Åbo Län, Finland . . .	Oct. 21, 1901	159
530	3*n*	**Palézieux,** Lausanne, Switzerland .	Nov. 30, 1901	28
531	3*n*	**Mount Browne,** Evelyn County, New South Wales.	July 17, 1902	148
532	3*n*	**Caratash,** Smyrna, Asia Minor . .	Aug. 22, 1902	10
533	3*n*	**Crumlin,** County Antrim, Ireland .	Sept. 13, 1902	4,239
534	3*n*	**Bath Furnace,** Bath County, Kentucky, U.S.A.	Nov. 15, 1902	1,013

B. Fall not Recorded.

[Arranged topographically.]

No.	Pane.	Name of Meteorite and Place of Find.	Report of Find.	Weight in grams.
535	3*o*	**Mainz,** Hesse, Germany. Described in 1857 by Seelheim: it had been turned up by a plough some years before.	Jahrb. d. Ver. für Naturk. im Nassau, 1857, p. 405.	33
536	3*o*	**Oczeretna,** Lipovitz, Kiev, Russia. Found in the summer of 1871.		117
537	3*o*	**Assam,** India. Found in 1846 in the refuse of the "Coal and Iron Committee's" collections, probably obtained from Assam.	Proc. Asiatic Soc. Bengal, June, 1846, pp. xlvi, lxxvi.	538
538	4*h*	**Goalpara,** Assam, India. Found among some specimens obtained from the neighbourhood of Goalpara: described by Haidinger in 1869.	Wien. Akad. Ber. 1869, vol. 59, part 2, p. 665.	1,187
539	3*o*	**Barratta,** Deniliquin, New South Wales. One person thought he saw it fall in the month of May, about 1860: another reports that he saw the mass lying on the ground in 1845.	Trans. Roy. Soc. of New South Wales, 1872, vol. 6, p. 97.	2,724
		Two other masses were described by Liversidge in 1902.	Jour. and Proc. Roy. Soc. New South Wales, 1902, vol. 36, p. 350.	
540	3*o*	**Gilgoin,** New South Wales: described by Russell in 1889.	Jour. & Proc. Roy. Soc. New South Wales, 1889, vol. 23, p. 47.	1,980
		A second mass, found later, was described by Liversidge in 1902.	Jour. & Proc. Roy. Soc. New South Wales, 1902, vol. 36, p. 354.	
541	3*o*	**Makariwa,** Invercargill, New Zealand. Found in clay, about 2½ ft. from the surface, in 1879: described by Ulrich and L. F. in 1893–4.	Proc. Roy. Soc., 1893, vol. 53, p. 54: Mineralog. Magazine, 1894, vol. 10, p. 287.	62
542	3*o*	**Tomhannock Creek,** Rensselaer County, New York, U.S.A. Found about the year 1863: described by Bailey in 1887: Brezina points out a close likeness of this stone, and also of "Yorktown," to those of West Liberty.	Amer. Jour. Sc. 1887, ser. 3, vol. 34, p. 60: Ann. d. k. k. Naturh. Hofmus. Wien, 1896, vol. 10, p. 251.	17
543	3*o*	**Morristown,** Hamblen County, Tennessee, U.S.A. Found in 1887: described by Eakins in 1893.	Amer. Jour. Sc. 1893, ser. 3, vol. 46, p. 283.	561

No.	Pane.	Name of Meteorite and Place of Find.	Date of Find.	Weight in grams.
544	3*o*	**Waconda,** Mitchell County, Kansas, U.S.A. Found in 1873 in the grass, upon the slope of a ravine: described by Shepard and by Patrick in 1876.	Amer. Jour. Sc. 1876, ser. 3, vol. 11, p. 473: Trans. Kansas Ac. Sc. 1876, vol. 5, p. 12.	467
545	3*o*	**Prairie Dog Creek,** Decatur County, Kansas, U.S.A. Reported and described by Weinschenk in 1895.	Tschermak's Min. und Petrog. Mitth. 1894-5, vol. 14, p. 471.	525
546	3*o*	**Long Island,** Phillips County, Kansas, U.S.A. Reported and described by Weinschenk in 1895.	*Ibid.*	1,289
547	3*o*	**Oakley,** Logan County, Kansas, U.S.A. Found in 1895: described by Preston in 1900.	Amer. Jour. Sc. 1900, ser. 4, vol. 9, p. 410.	2,495
548	3*o*	**Kansada,** Ness County, Kansas, U.S.A. Found in 1894.		2,010
549	3*o*	**Ness City,** Ness County, Kansas, U.S.A. Found in 1898: described by Ward in 1899.	Amer. Jour. Sc. 1899, ser. 4, vol. 7, p. 233.	668
550	3*o*	**Utah,** U.S.A. Found in 1869 on the open prairie between Salt Lake City and Echo, Utah: described by Dana and Penfield in 1886.	Amer. Jour. Sc. 1886, ser. 3, vol. 32, p. 226.	4
551	3*o*	**McKinney,** Collin County, Texas, U.S.A.		290
552	3*o*	**Bluff,** 3 miles S. W. of La Grange, Fayette County, Texas. Found about 1878, and described by Whitfield and Merrill in 1888.	Amer. Jour. Sc. 1888, ser. 3, vol. 36, p. 113.	12,700
553	3*o*	**Pipe Creek,** Bandera County, Texas, U.S.A. Found in 1887: described by Ledoux in 1888–9.	Trans. of New York Ac. of Sc., 1888–9, vol. 8, p. 186.	821
554	3*o*	**The Lutschaunig Stone,** Atacama, Chili.	Mineralog. Magazine, 1889, vol. 8, p. 234.	92
555	3*o*	**Carcote,** Atacama, Chili, S. America. Known since 1888: described by Sandberger in 1889.	Neues Jahrb. f. Min., 1889, vol. 2, p. 173.	2
556	3*o*	**Minas Geraes** (?), Brazil. Found without label among specimens which may have been brought from Minas Geraes: mentioned by Derby in 1888.	Revista do Observatorio, Rio de Janeiro, 1888.	3
557	3*o*	**Indio Rico,** Buenos Ayres, Argentina. Described by Kyle in 1887.	Anales de la Sociedad Científica Argentina, 1887, vol. 24, p. 128.	1·5

LIST OF BRITISH METEORITES.

Of the above meteorites the following have fallen in Great Britain or Ireland :—

	Name.	Date of Fall.
1. In England—	**Wold Cottage**	December 13, 1795
	Launton	February 15, 1830
	Aldsworth	August 4, 1835
	Rowton	April 20, 1876
	Middlesbrough	March 14, 1881
2. In Scotland—	**High Possil**	April 5, 1804
	Perth	May 17, 1830
3. In Ireland —	**Mooresfort**	August, 1810
	Limerick	September 10, 1813
	Killeter	April 29, 1844
	Dundrum	August 12, 1865
	Crumlin	September 13, 1902

One of them, Rowton, is a meteoric iron; the rest are meteoric stones.

APPENDIX A.

NATIVE IRON (of terrestrial origin).
(Pane $4m$.)

Name of Iron and Place of Find.	Report of Find.
Niakornak, Jakobshavn District, West Greenland (Rink's iron). Part of a lump obtained (1848–50) by Dr. Rink from a Greenlander who lived at Niakornak: it had been found not far from his home, lying loose on a pebble-strewn plain near the coast.	Oversigt over det koniglike danske vidensk. selsk. forh. 1854, p. 1.
Jakobshavn, West Greenland (The Pfaff-Öberg iron). Part of a lump given by Dr. Pfaff of Jakobshavn to Dr. Öberg in 1870: it was said to have been found in the neighbourhood (perhaps near Niakornak).	Geological Magazine, 1872, vol. 9, p. 520.
Ovifak, Disko Island, West Greenland. Found by Baron N. A. E. Nordenskiöld in 1870.	Geological Magazine, 1872, vol. 9, p. 460.
New Zealand (Jackson's Bay). Found in 1885, and described by Skey in the same year (Awaruite).	Trans. and Proc. of New Zealand Institute, 1885, vol. 18, p. 401.
South America. Found in an old collection; described by Högbom in 1902.	Bull. of the Geol. Instit. of the Univ. of Upsala, 1902, p. 277.

APPENDIX B.

PSEUDO-METEORITES

WHICH HAVE BEEN DESCRIBED AS METEORITES (Drawers).

Aachen, Rhenish Prussia.
Braunfels, Coblenz.
Campbell County, Tennessee, U.S.A.
Canaan, Connecticut, U.S.A.
Collina di Brianza, Milan, Italy.
Concord, New Hampshire, U.S.A.
Gross-Kamsdorf, Saxony.
Heidelberg, Germany.
Haywood County, N. Carolina, U.S.A.
Hemalga, Desert of Tarapaca, S. America.
Hommoney Creek, Buncombe County, N. Carolina, U.S.A.
Igast, Livland, Russia.
Kamtschatka, Asiatic Russia.
Leadhills, Lanarkshire, Scotland.
Long Creek, Jefferson County, New York, U.S.A.
Magdeburg, Prussia.
Nauheim, Giessen, Germany.
New Haven, Connecticut, U.S.A.
Newstead, Roxburghshire, Scotland.
Nöbdenitz, Saxon Altenburg.
Richland, S. Carolina, U.S.A.
Rutherfordton, N. Carolina, U.S.A.
St. Augustine's Bay, Madagascar.
Scriba, Oswego County, New York, U.S.A.
South America.
Sterlitamak, Russia.
Voigtland, Saxony.
Waterloo, New York, U.S.A.

LIST OF THE CASTS OF METEORITES.

Meteorites are generally represented in collections by mere fragments of the original specimens, which often fail to give any idea of the original size and shape. Before division of a specimen a cast of it is sometimes prepared, and a representation of the size and shape is thus preserved.

Casts of most of the following meteorites are exhibited in the lower parts of the cases :—

Akburpur.
Assisi.
Barranca Blanca.
Babb's Mill.
Barratta
Beuste.
Bingera.
Bithur.
Bugaldi.
Braunau.
Breitenbach.
Buschhof.
Bustee.
Butsura.
Cabin Creek.
Cachiyuyal.
Caperr.
Chandakapur.
Charlotte.
Chulafinnee.
Cronstadt.
Crumlin.
Daniel's Kuil.
Dolgovoli.
Donga Kohrod.
Dundrum.
Durala.
Goalpara.
Gopalpur.
Ibbenbühren.
Jelica.
Jhung.
Kaee.
Khiragurh.
Klein-Menow.
Launton.
Lick Creek.
Linum.
Mazapil.
Mhow.
Middlesbrough.
Mooresfort.
Mouza Khoorna.
Nagy-Diwina.
Nash County.
Nedagolla.
Nejed.
Nellore.
Nerft.
Newstead.
New Zealand.
Obernkirchen.
Ogi.
Parnallee.
Petersburg.
Pillistfer.
Pulsora.
Rancho de la Pila.
Rittersgrün.
Roebourne.
Rowton.
St. Denis Westrem.
Sarepta.
Segowlie.
Shytal.
Sindhri.
Sitathali.
Ski.
Udipi.
Virba.
West Liberty.
Wittekrantz.

The Trustees possess moulds of those meteorites in the preceding list of which the names are printed in italics, and casts may be obtained on payment of the necessary expenses. Applications should be made in writing to the formatori, D. Brucciani & Co., 254 Goswell Road, London, E.C.

INDEX

TO THE METEORITES REPRESENTED IN THE COLLECTION.

The names adopted for the meteorites are printed in thick type: the other names are synonyms.
The numbers correspond with those of the first column of the meteorite list.

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